γ-Jet Studies

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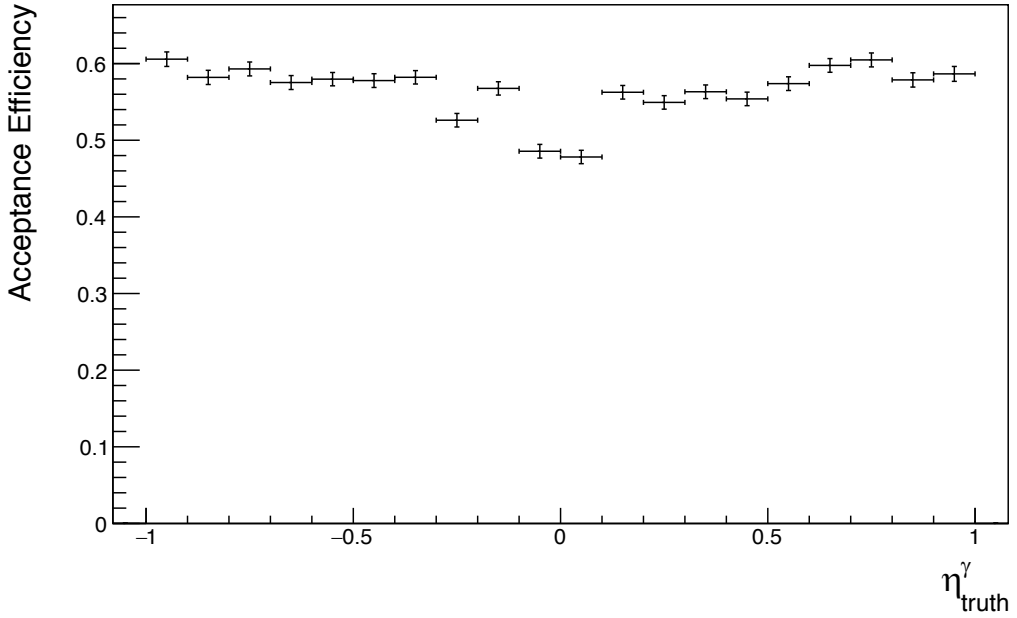
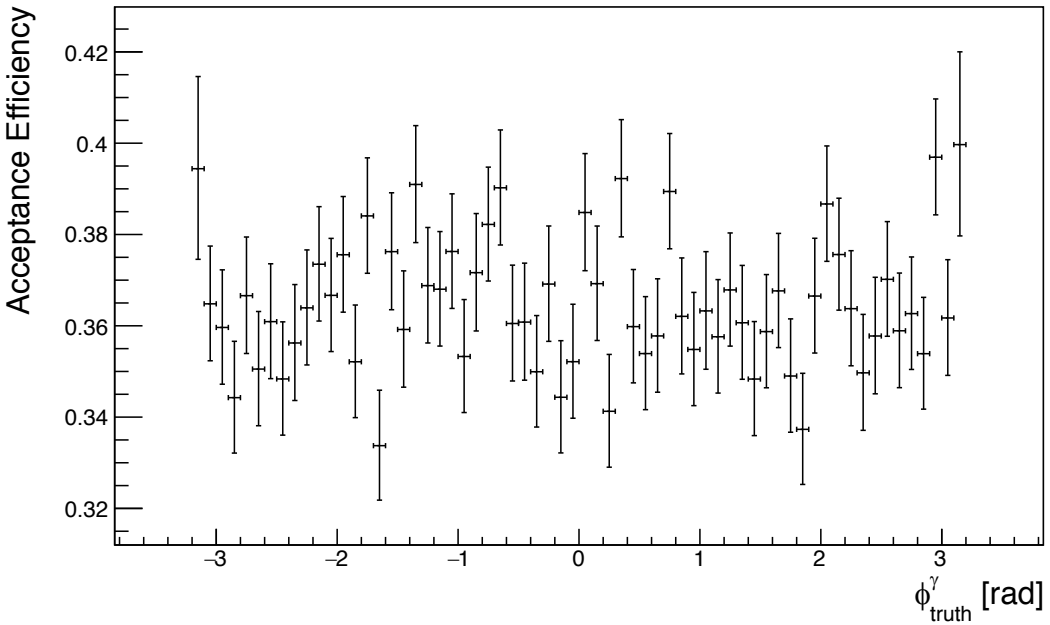
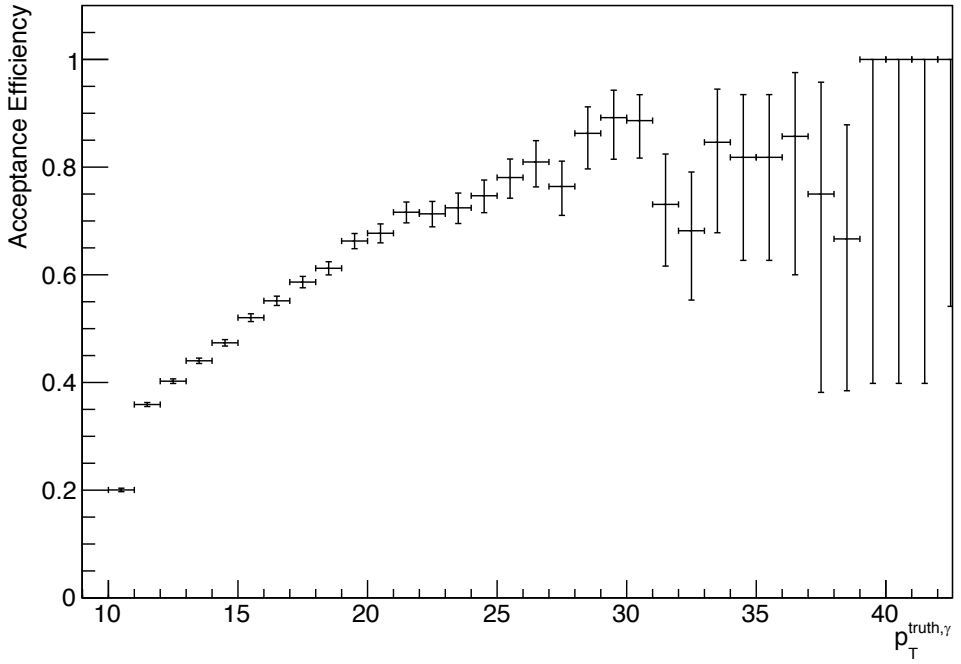
Overview

- Last presentation: Feb. 14
- Showed acceptance and efficiency studies as well as some jet response studies
- Raised question of whether or not acceptance/efficiency values made sense
- Today:
  - Some photon characteristics to support acc/eff determination
  - Single photon gun + G4 response

Reminder: Photon-jet Acceptance/Efficiency



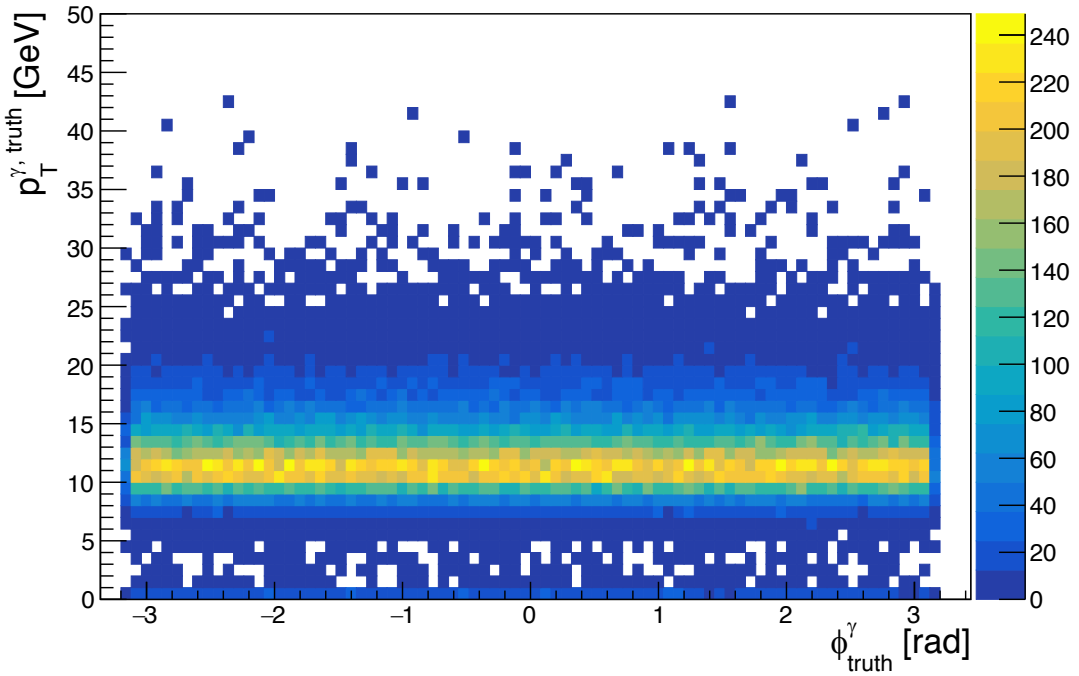


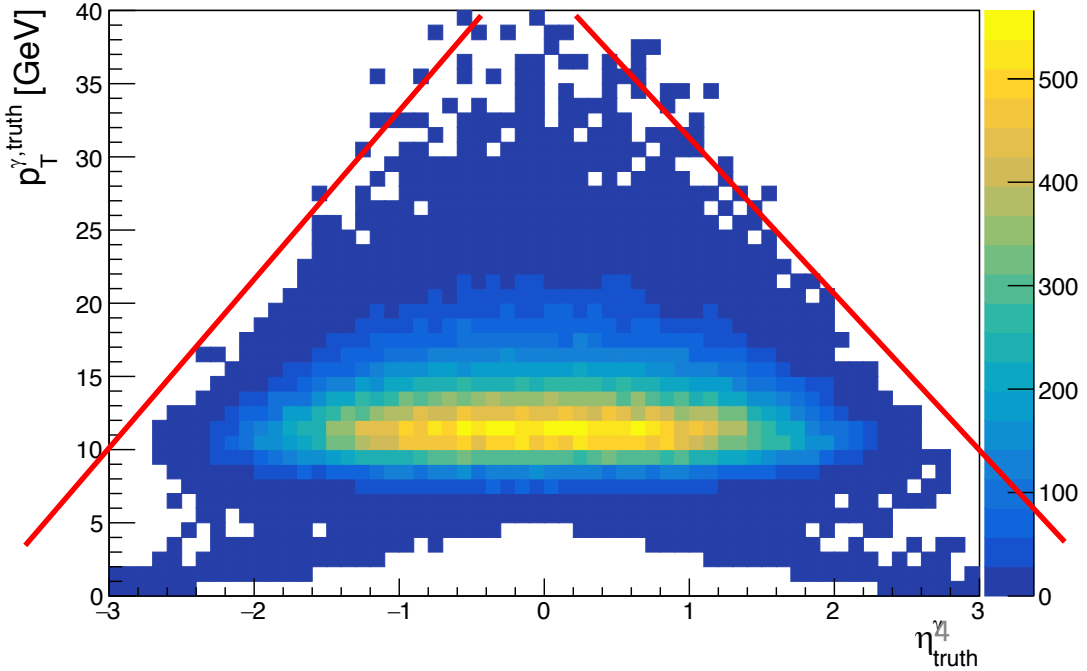


- Reminder from last time –
  - Acceptance and efficiency for photon+jet is flat with ϕ and η
  - Clear p_T dependence, approaches 1 at high p_T
  - I found a small bug in the code, but the behavior is the same; just shifted down slightly
  - Some discussion with Stefan about why this is

Angular Response for γ

- η truth response is confined to $|\eta|<1$ at $p_T>25$ish
  - This matches the efficiency towards 1 with increasing p_T
- This also reinforces discussion with Stefan that the effect is from kinematics
- i.e. as p_T increases one probes a larger x in the proton and thus is constrained kinematically to certain polar angle scatterings





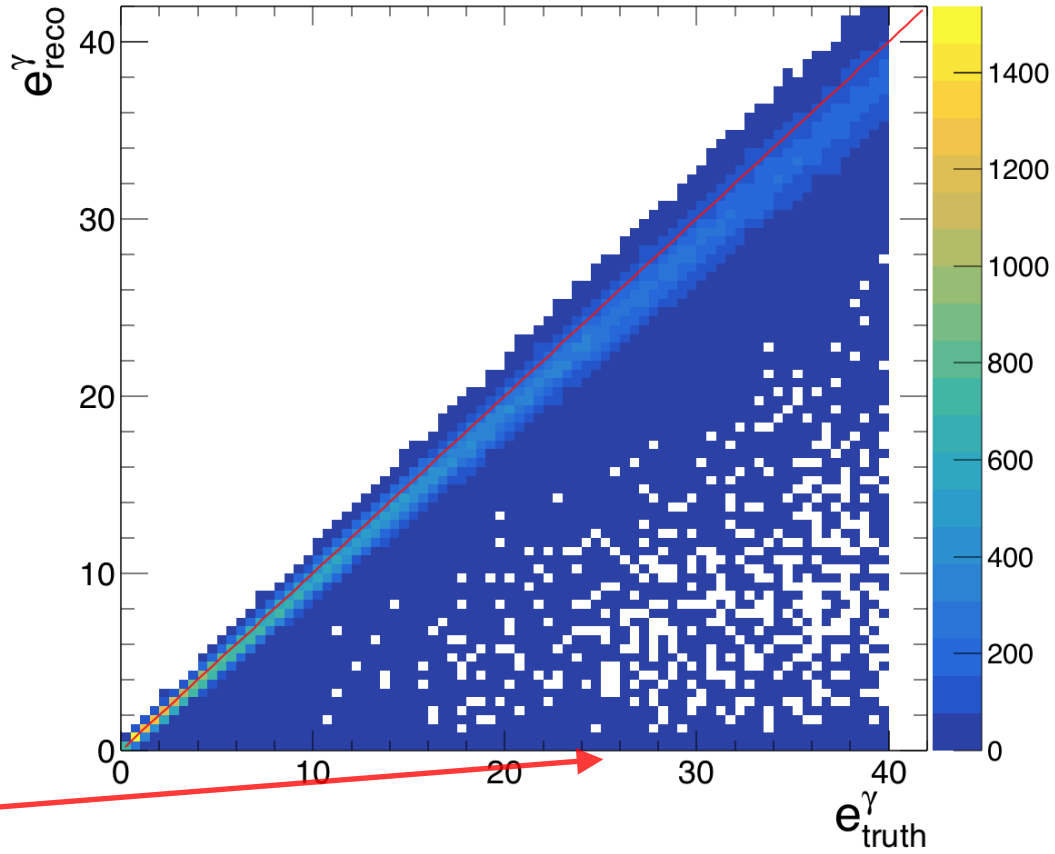
sPHENIX Photon Response

sPHENIX Photon Detector Response

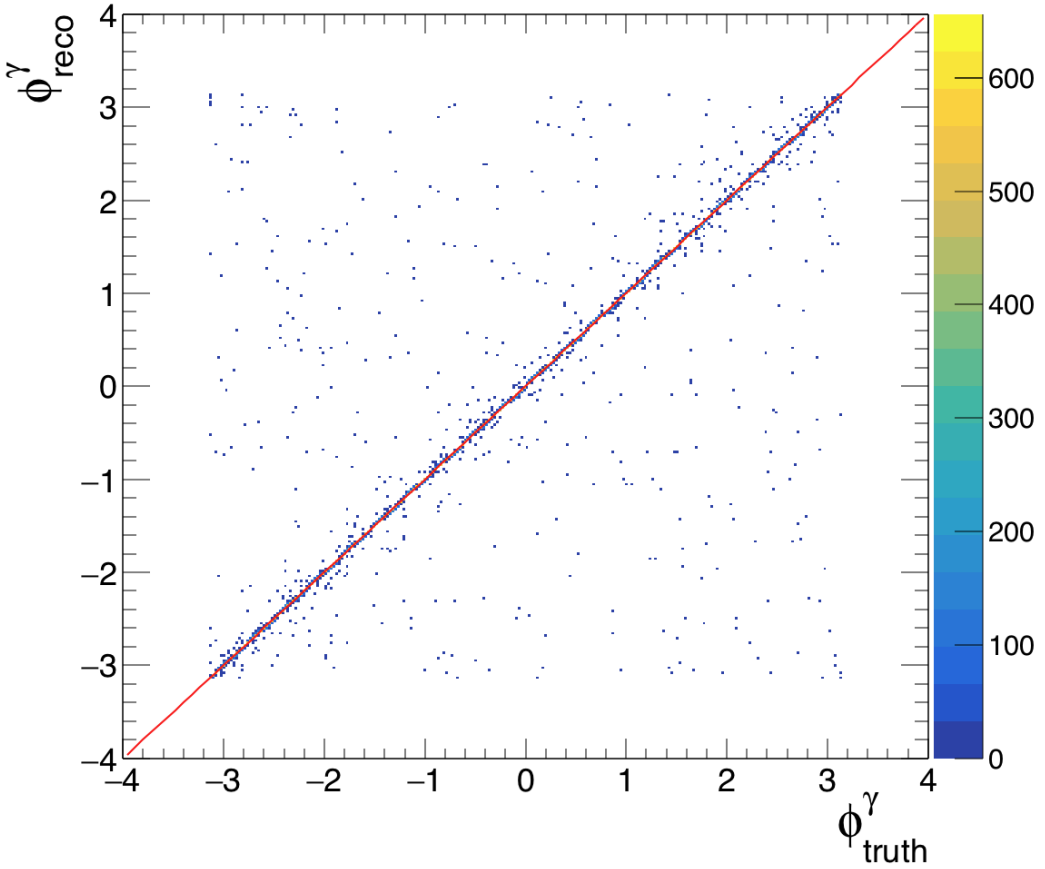
- Some discussion last time I presented how there have not been dedicated single photon simulation studies
- I ran single particle photon gun through the G4 sPHENIX detector
  - Single photons, flat in p_T with $0.2<p_T<40$ GeV and $|\eta|<1.2$ in full azimuth
- If there are other suggestions for observables to look at, by all means make them
  - I have the trees with truth and reco photons

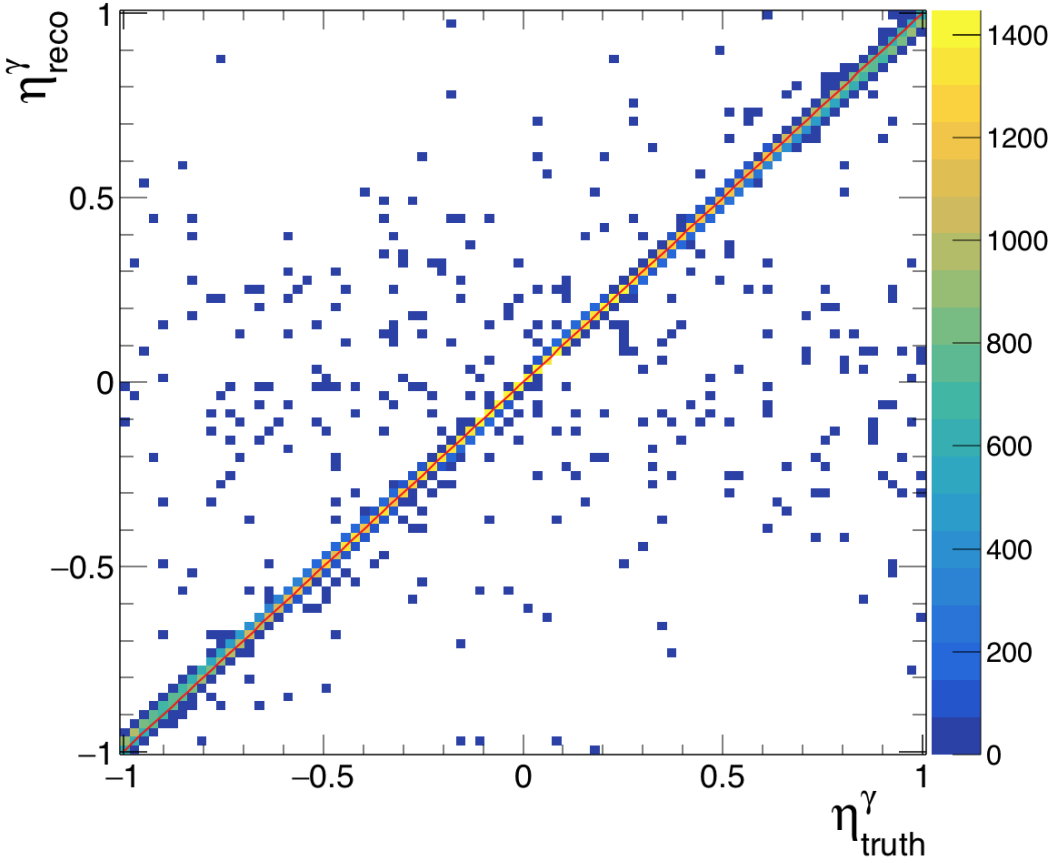
Photon Energy

- Energy reco vs energy truth looks pretty standard from what we have seen so far
- Each reco photon in the event is matched with the event truth photon
- This explains this low energy junk – probably from radiation or interactions with the detector



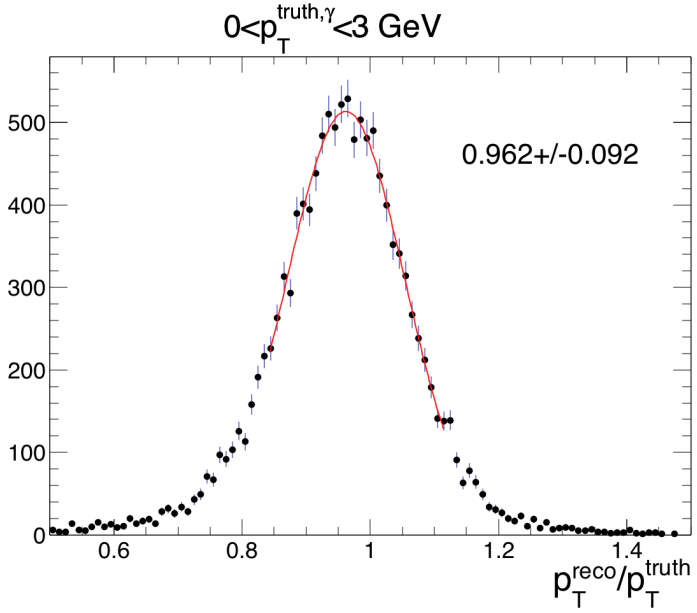
Photon Angular Response

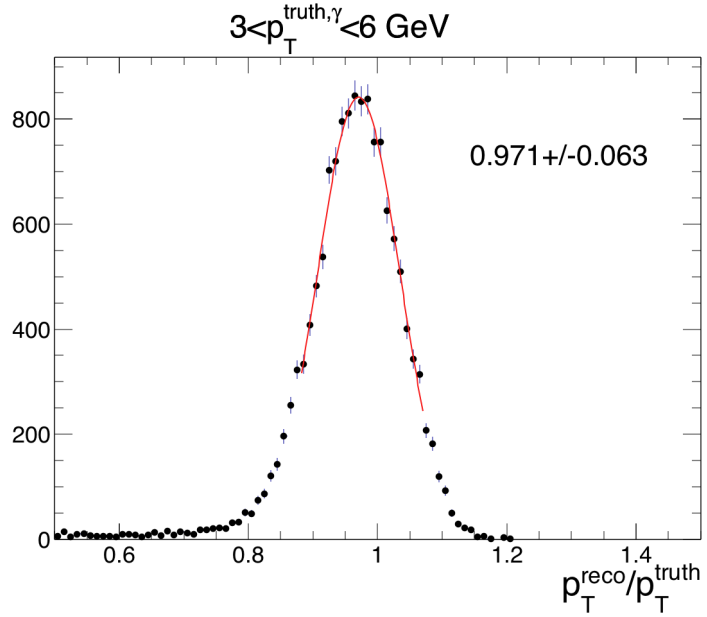


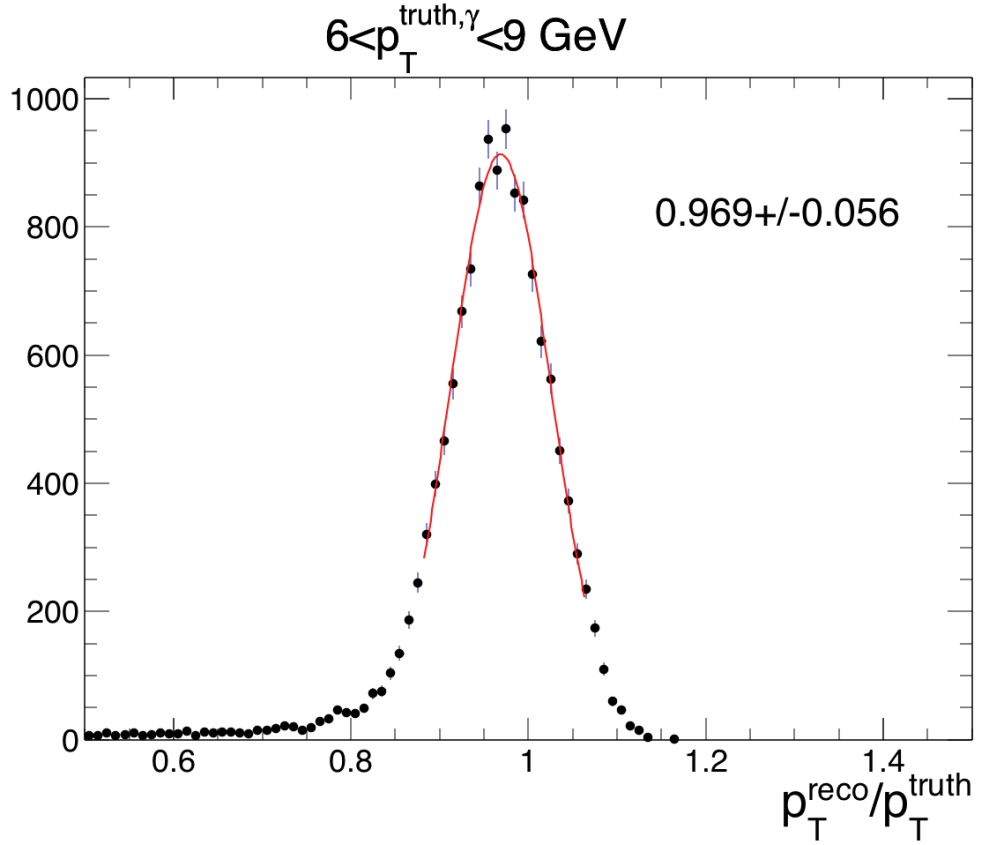


Random points away from y=x again likely due to random junk photons matched with the truth photon

1D p_T Histograms

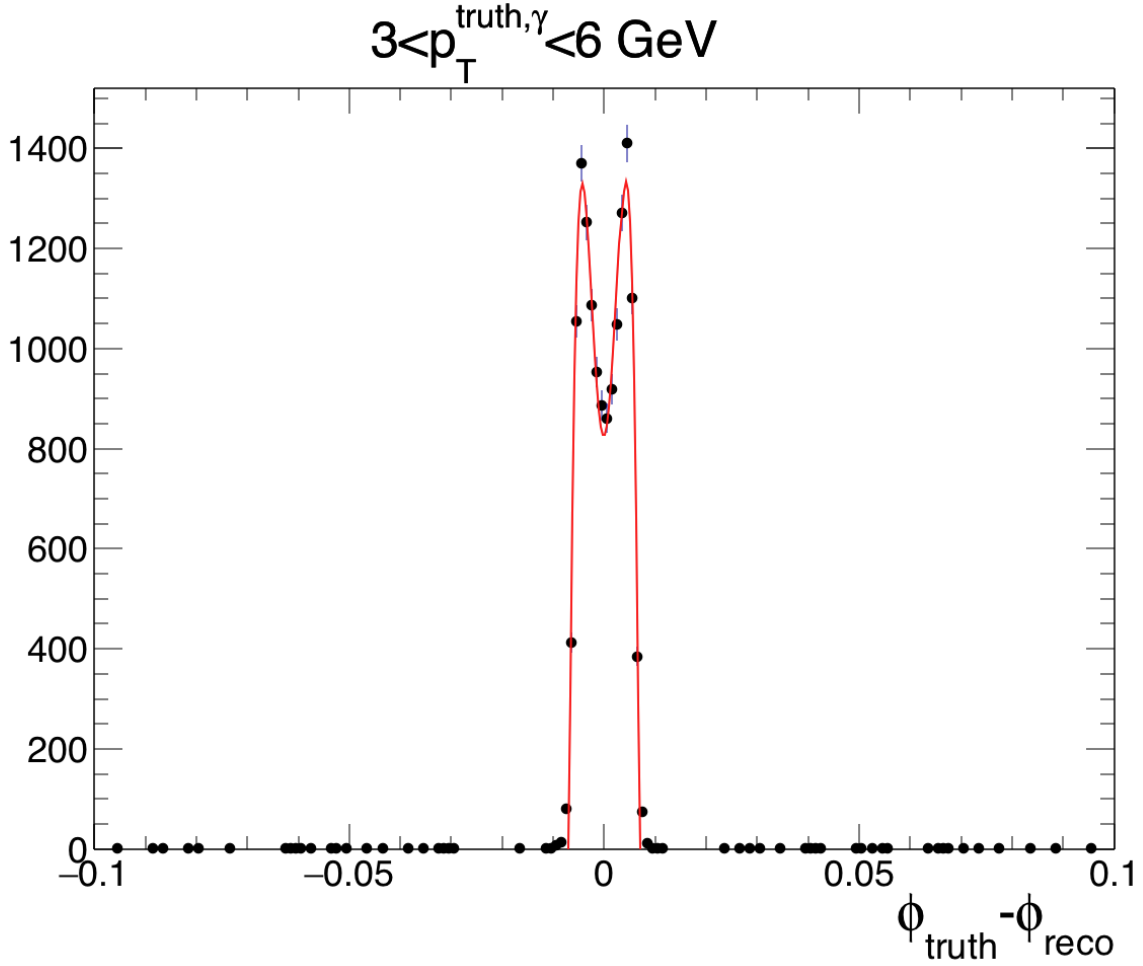






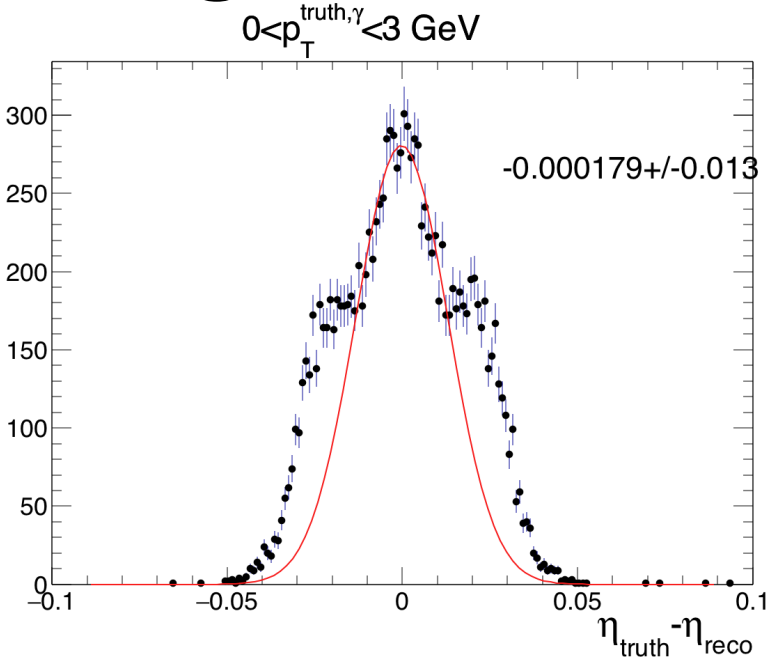
- Nominal p_T response of ~0.95±0.04 achieved by ~6 GeV
- Lower p_T has noticeably worse resolution (obviously)
- Could make finer bins at low p_T if there is interest

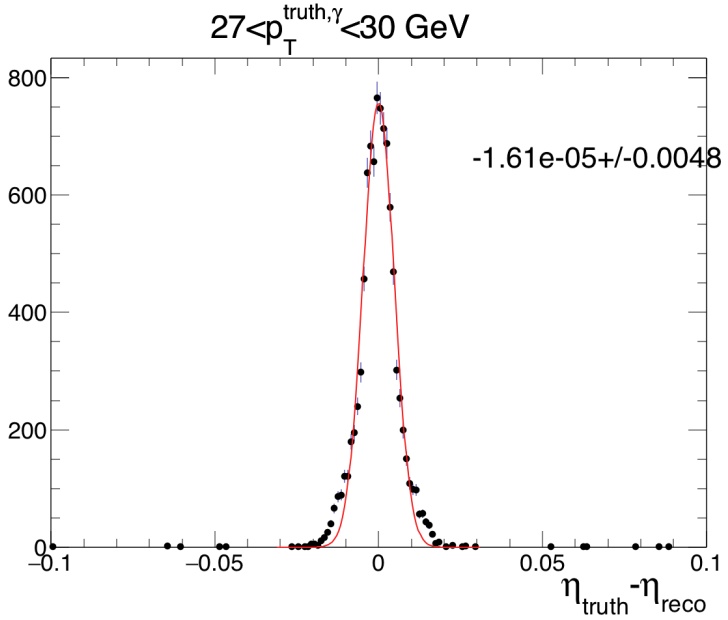
1D Angular Histos Show Interesting Features



- ϕ response shows bimodal structure at all p_T
- Distributions are fit to a 4th order polynomial to highlight this behavior
- Perhaps these bins are smaller than inherent tower resolution?
  - According to the sPHENIX proposal the tower resolution is 0.024x0.024 in ΔηxΔϕ so this is probably the reason for the effect seen here
- This effect is only noticable within ϕ_{truth}-ϕ_{reco}~0.005
- All p_T bins in backups

1D Angular Histos Show Interesting Features



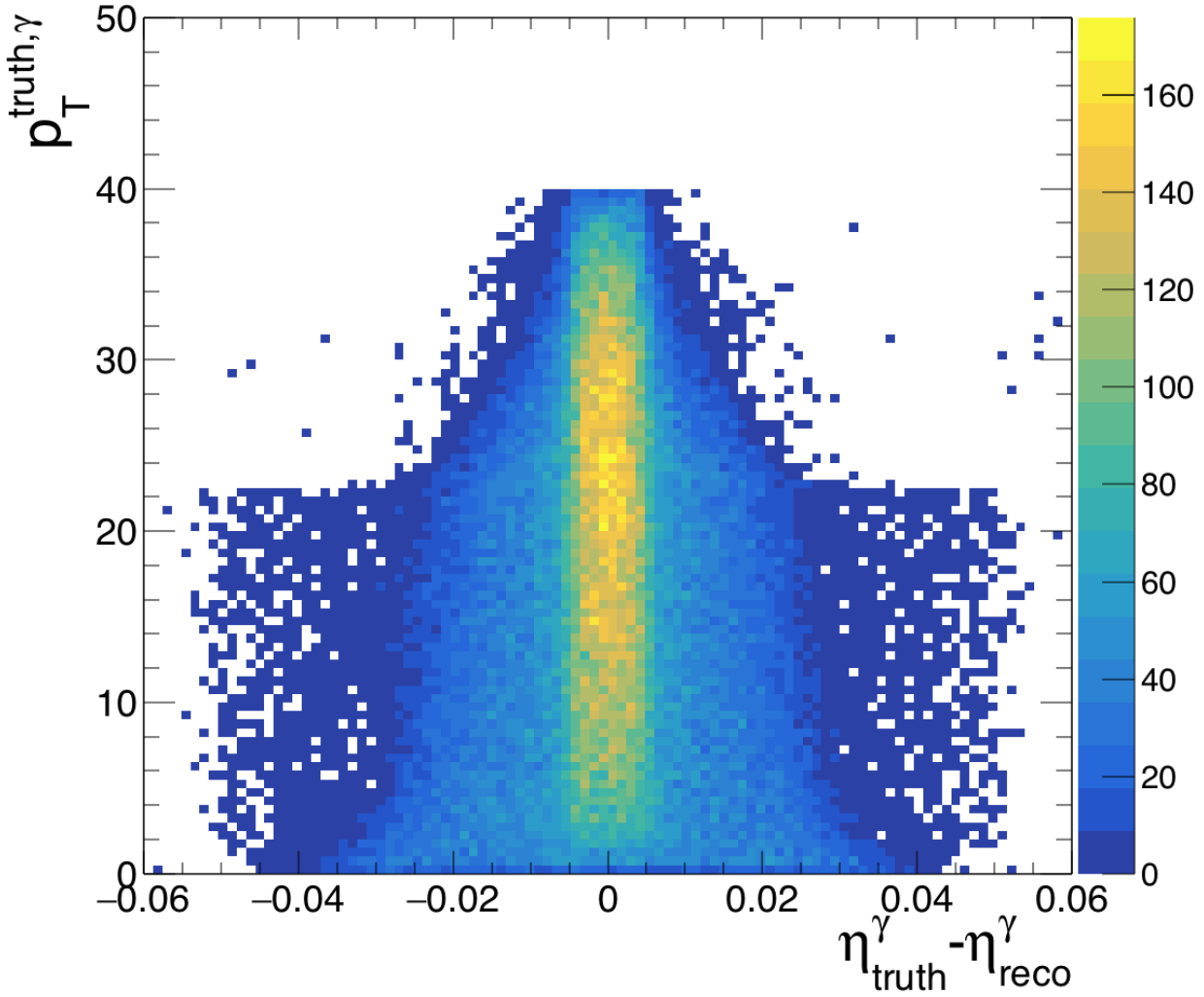


- η difference shows strange distribution too
- Gaussian function fit to the range that is clearly Gaussian, e.g. here the fit is between $-0.01<\Delta\eta<0.01$ and then extended to show the deviation from Gaussian
- This could be due to mismatched photons, since the behavior goes away at higher p_T (bottom left)

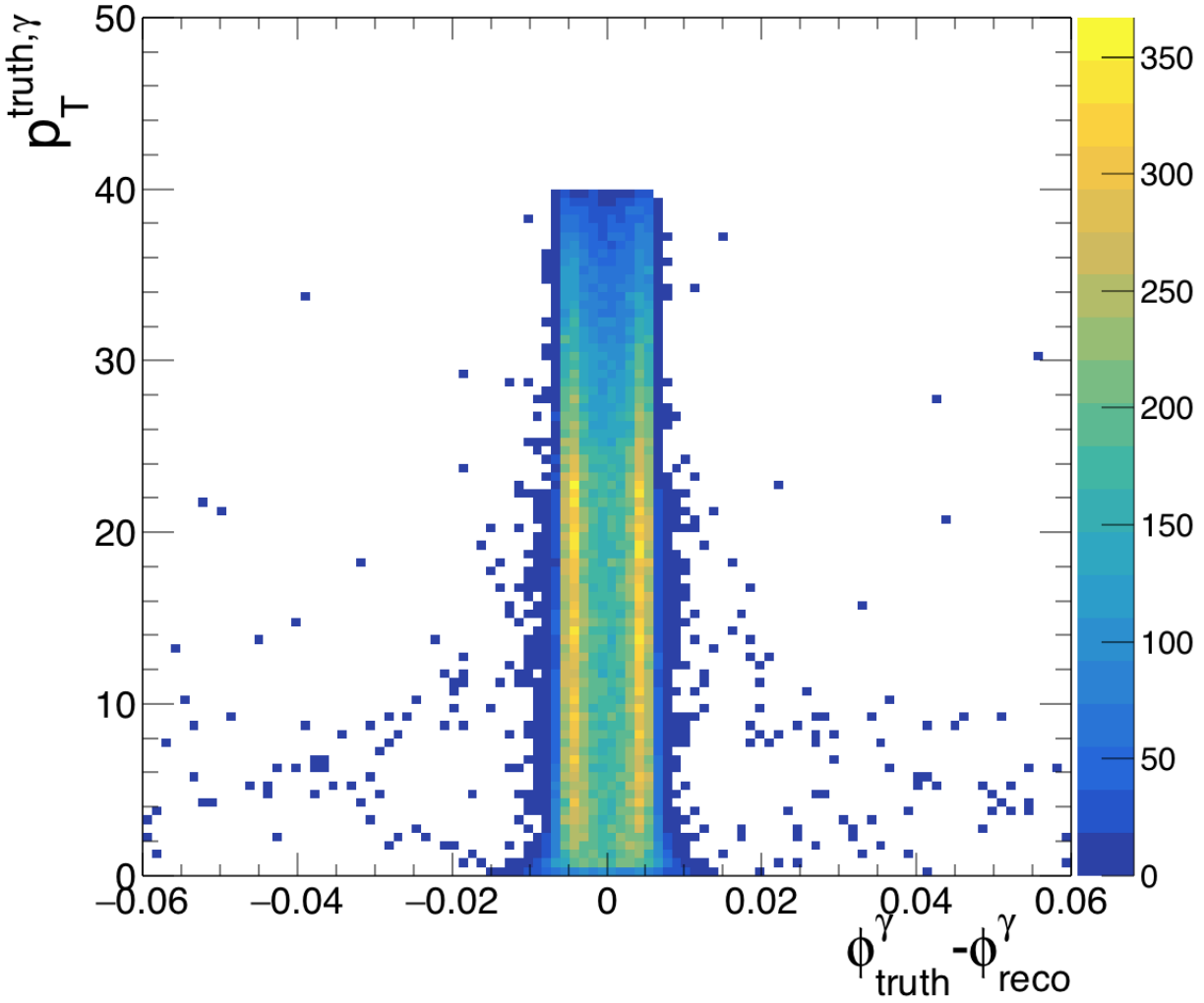
Conclusions

- Photon+jet acceptance and efficiency values make sense based on kinematics
- Revisited this just to close the loop
- Ran single photon particle gun simulations through G4 sPHENIX
  - Most things look pretty reasonable. Some questions about the η residuals…
- To-Do
  - Do others have suggestions for observables I can look at for photons?
  - Anything that would be considered valuable I can take a look at – I have the trees, just need some guidance

Back Ups

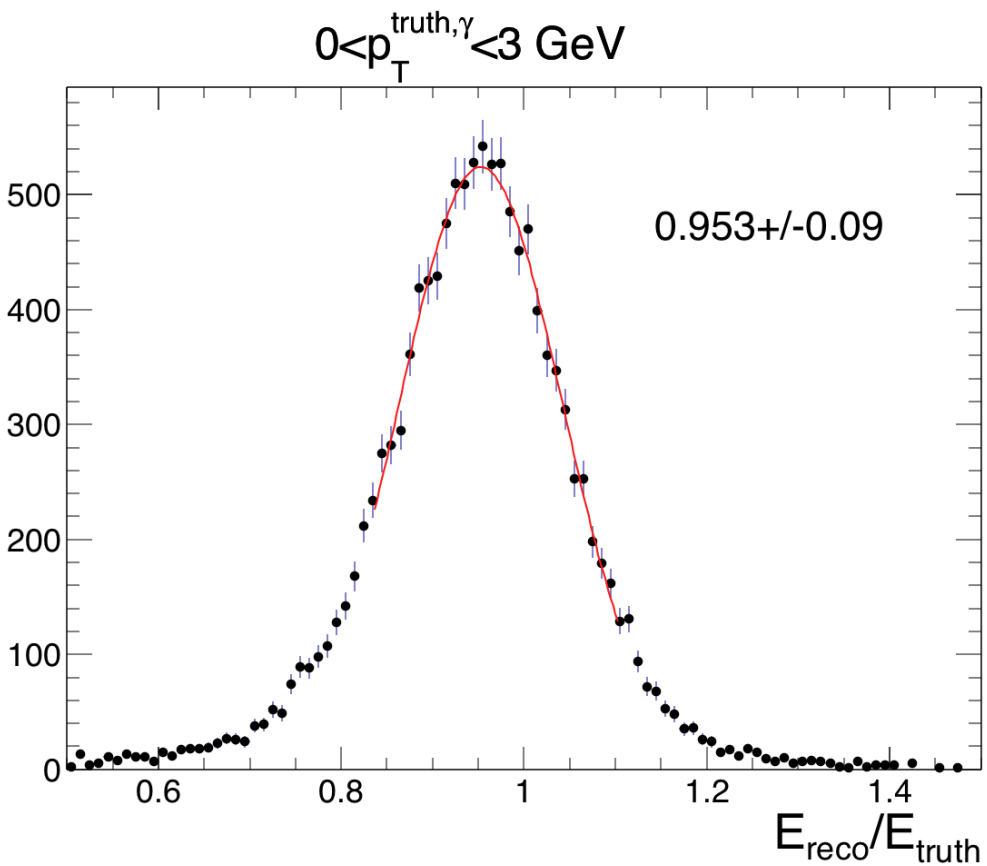


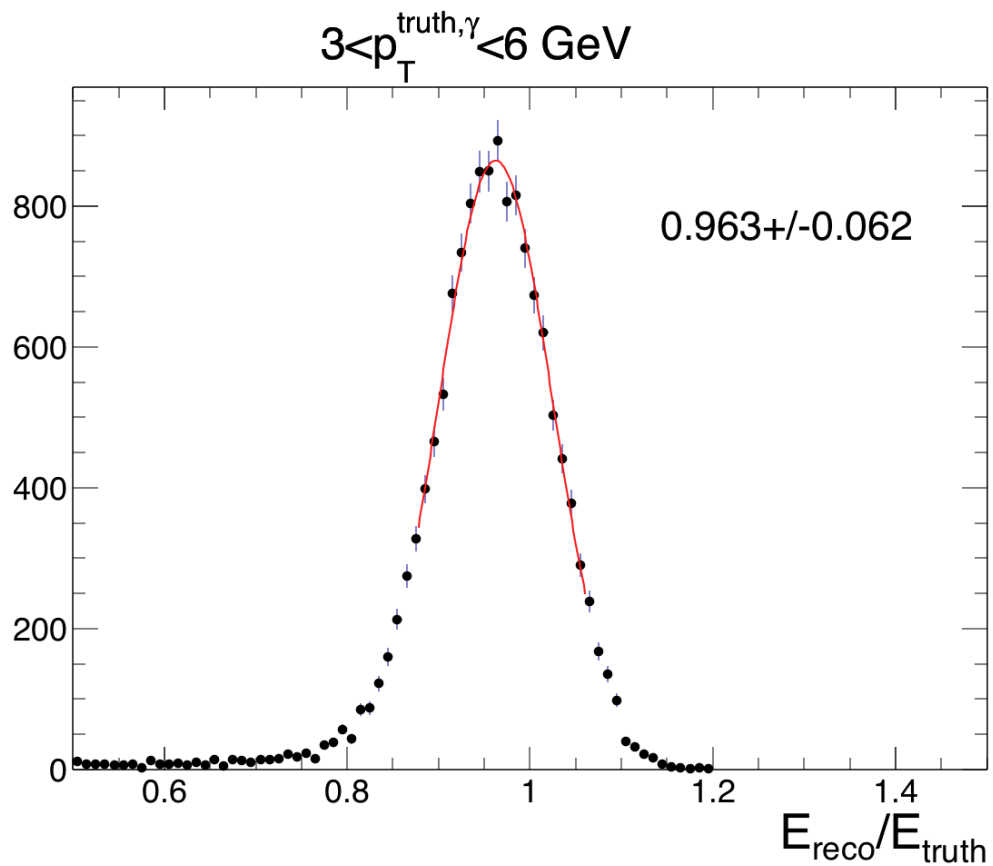
- 2D histogram shows the p_T dependence of the η difference
- Distributions are “fatter” with a central core at small p_T
- This behavior starts to go away at higher p_T

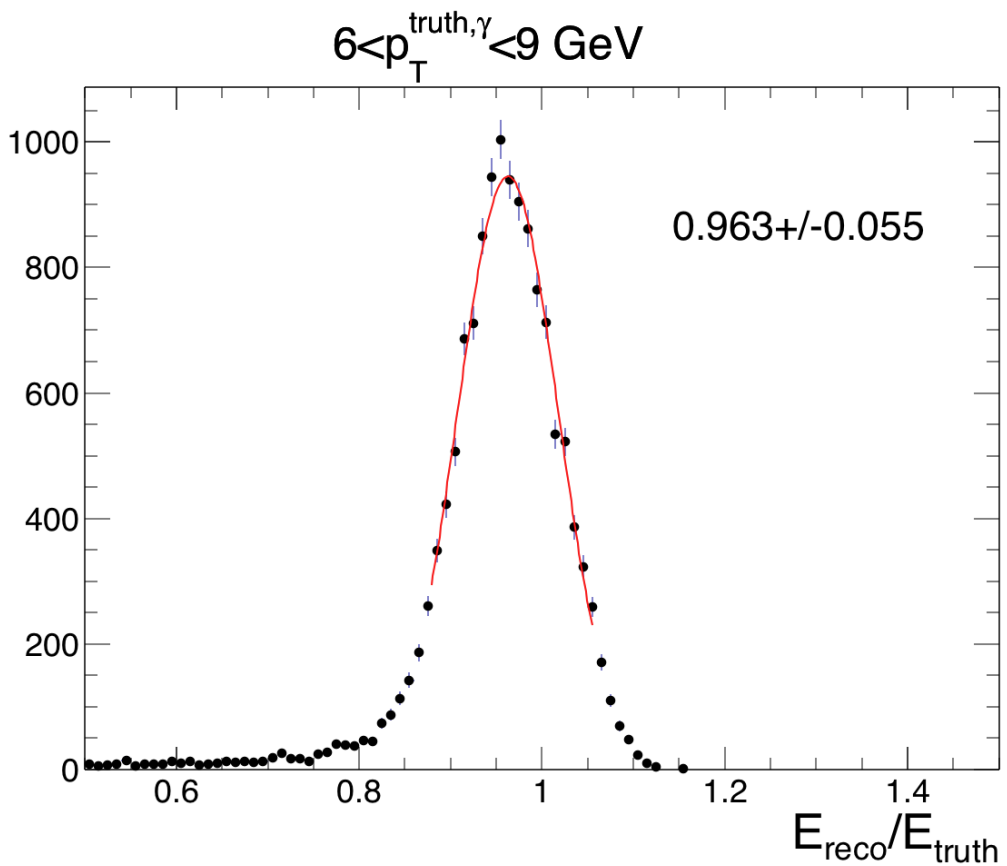


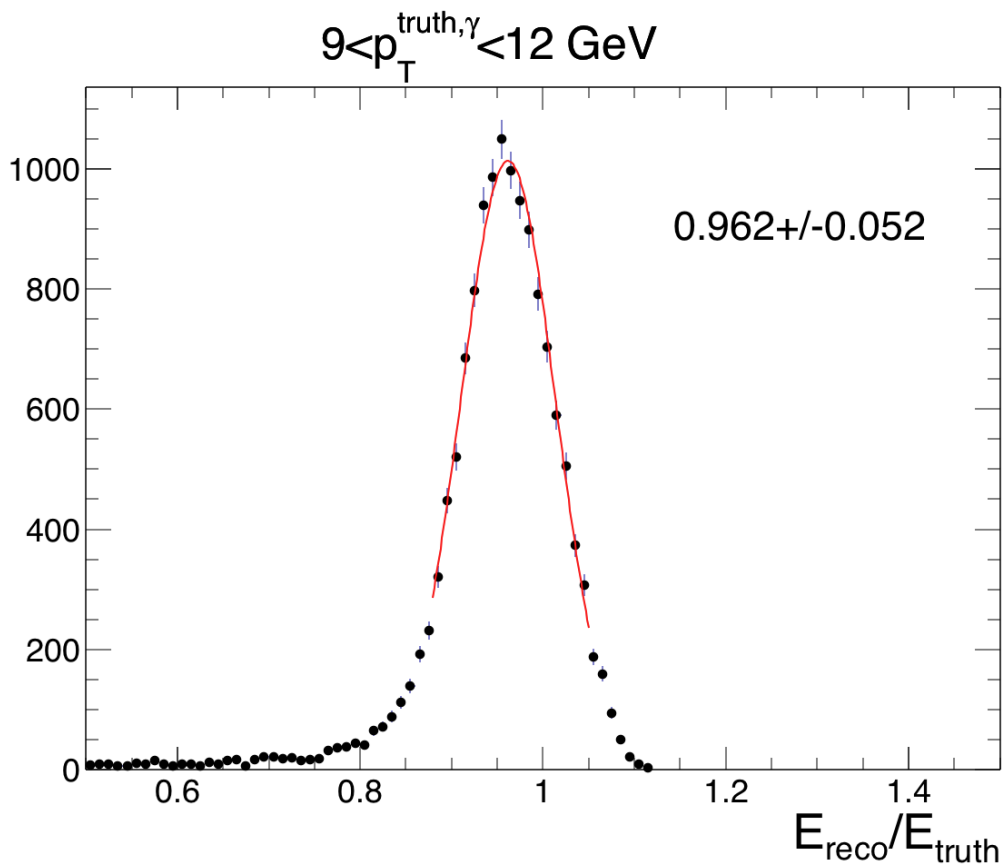
- 2D histogram shows bimodal behavior of ϕ response
- Starts to dissipate at higher p_T, but not completely

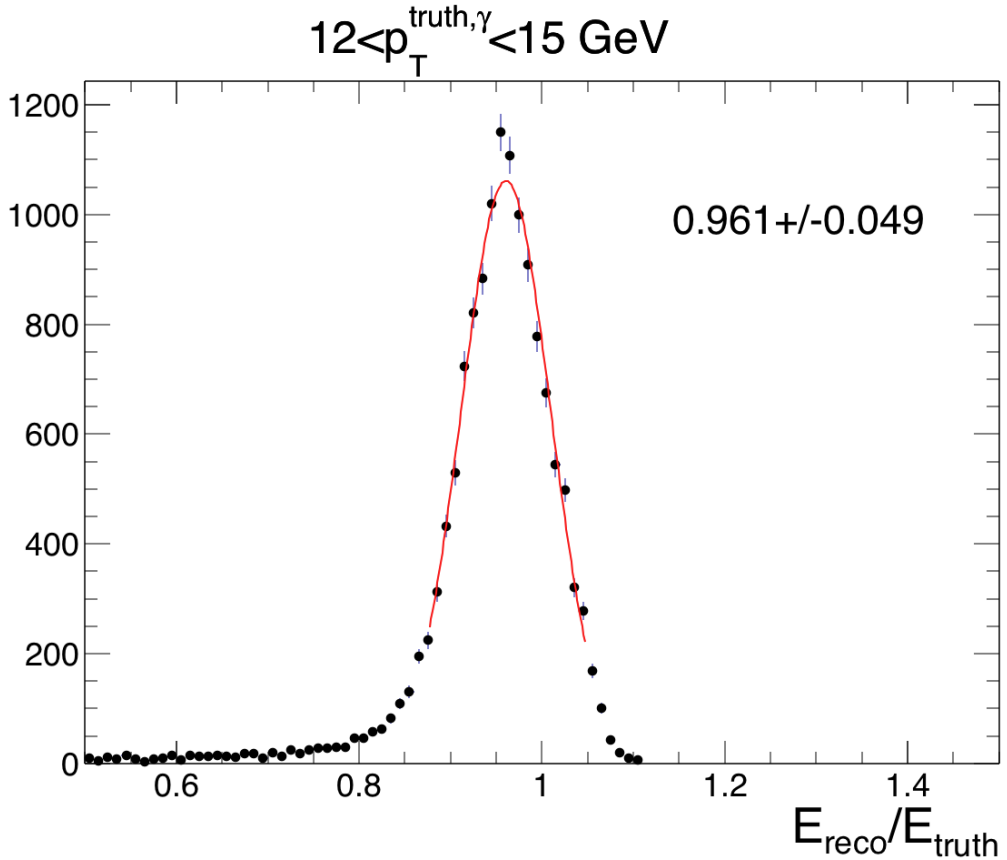
- The following plots are response plots in energy, p_T, ϕ, and η for the single photons in different p_T bins
- They are just 1D projections of the previous 2 pages in wider p_T bins
- The fits shown are all Gaussian fits, except for the ϕ response plots which are shown with polynomial 4 fits
- Note that the η fits are performed over a small region and then extended to show the deviation from Gaussian at larger $\Delta\eta=\eta_{truth}-\eta_{reco}$

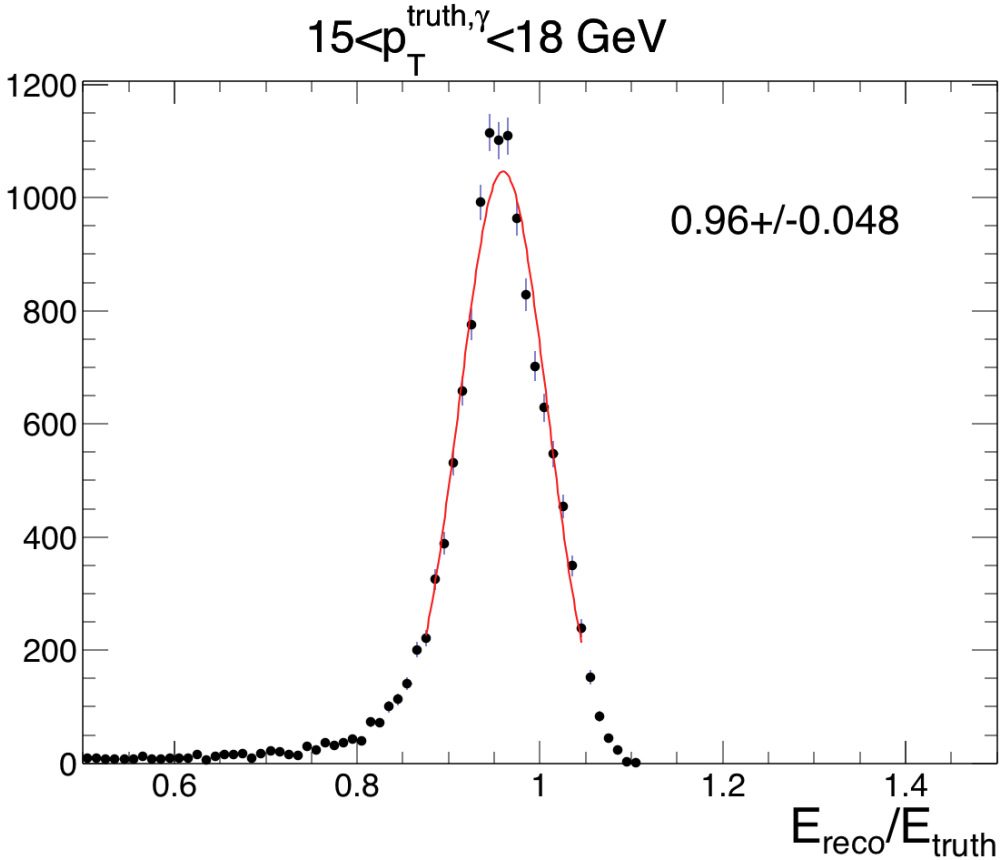

0<p_T^truth,γ<3 GeV
0.953+/-0.09
500
400
300
200
100
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth

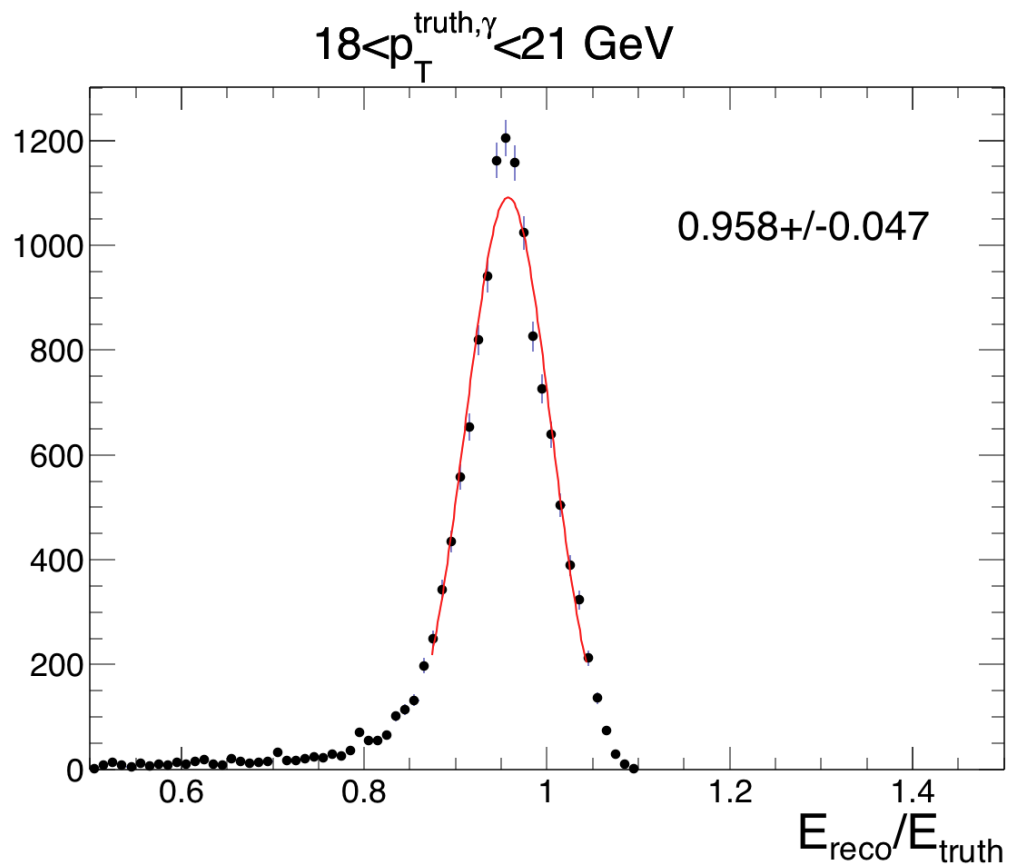

3<p_T^truth,γ<6 GeV
0.963+/-0.062
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth

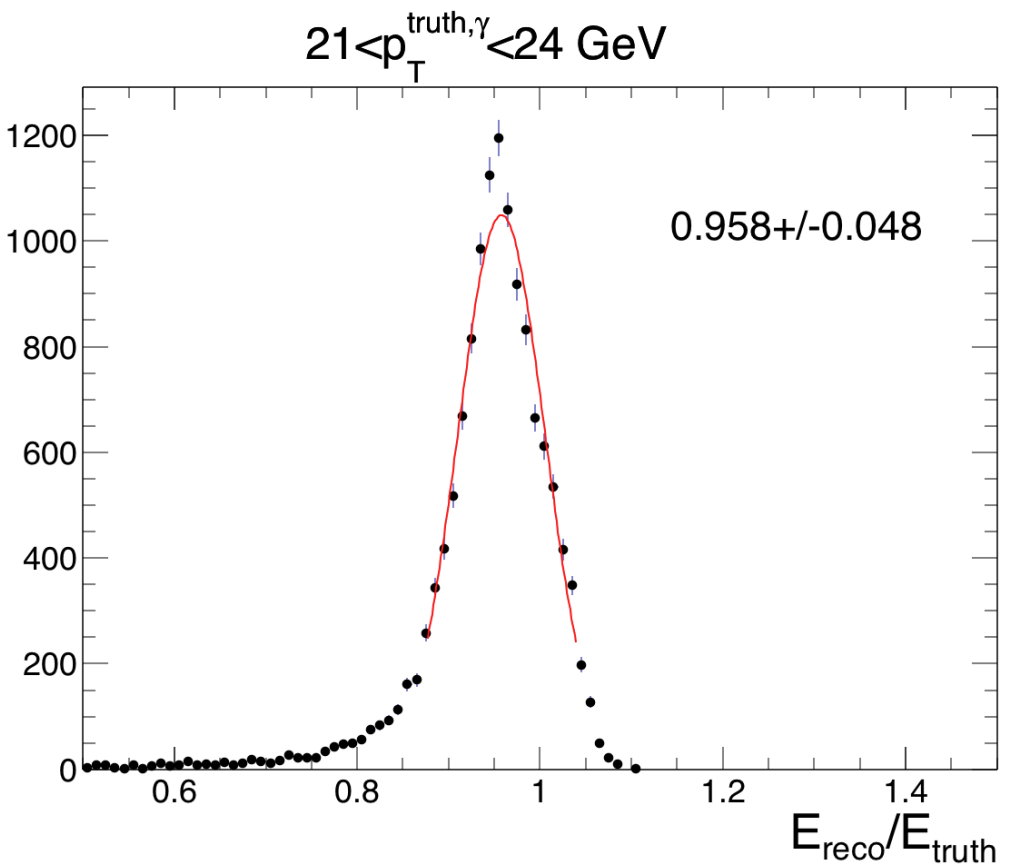

6<p_T^truth,γ<9 GeV
0.963+/-0.055
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth

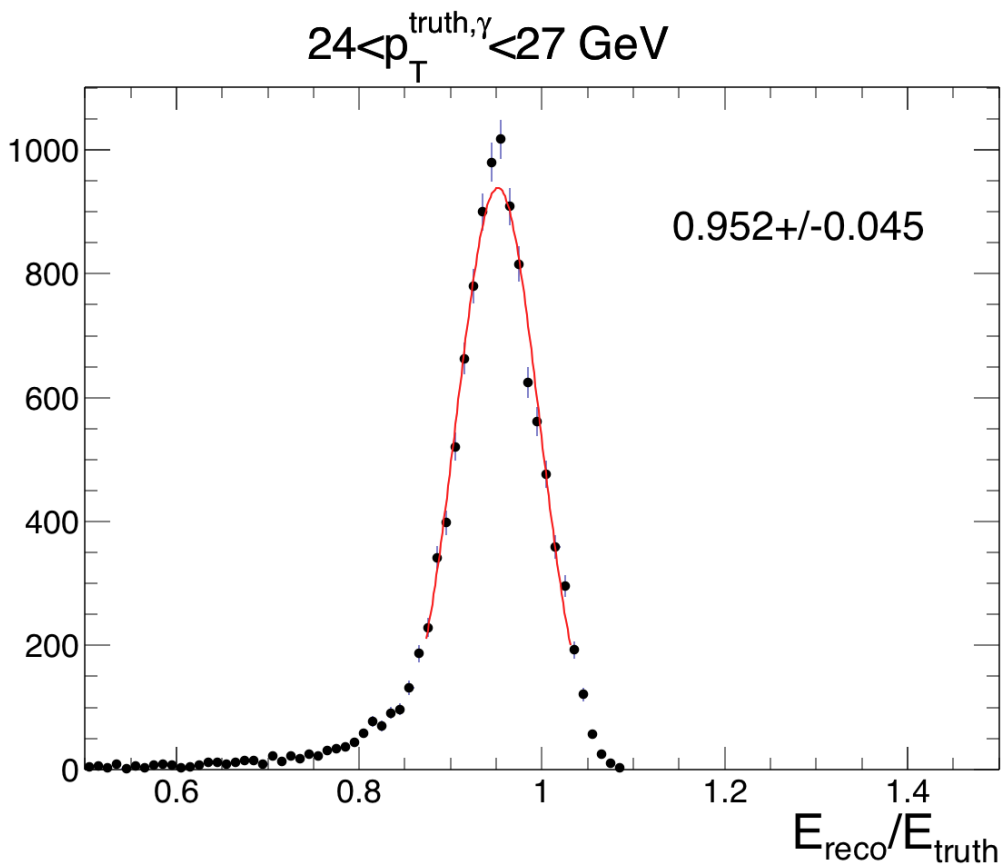

9<p_T^truth,γ<12 GeV
0.962+/-0.052
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth

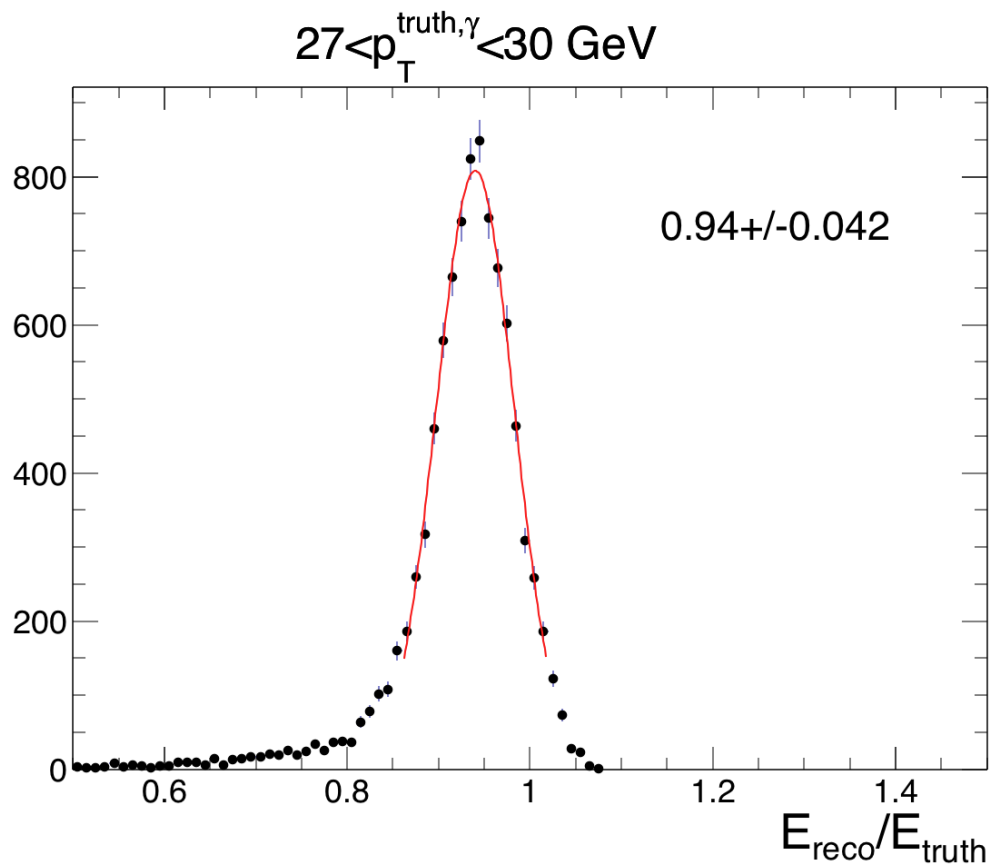

12<p_T^truth,γ<15 GeV
0.961+/-0.049
1200
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth

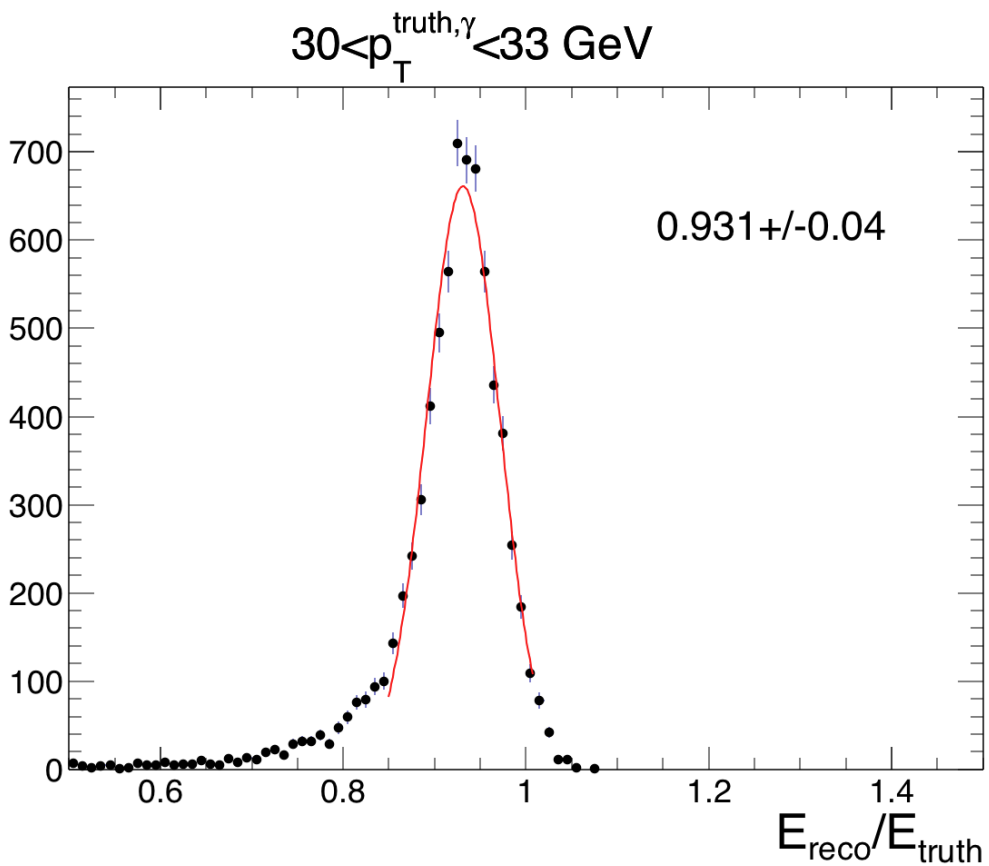

15<p_T^truth,γ<18 GeV
0.96+/-0.048
1200
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth


18<p_T^truth,γ<21 GeV
0.958+/-0.047
1200
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth


21<p_T^truth,γ<24 GeV
0.958+/-0.048
1200
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth


24<p_T^truth,γ<27 GeV
0.952+/-0.045
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth


27<p_T^truth,γ<30 GeV
0.94+/-0.042
800
600
400
200
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth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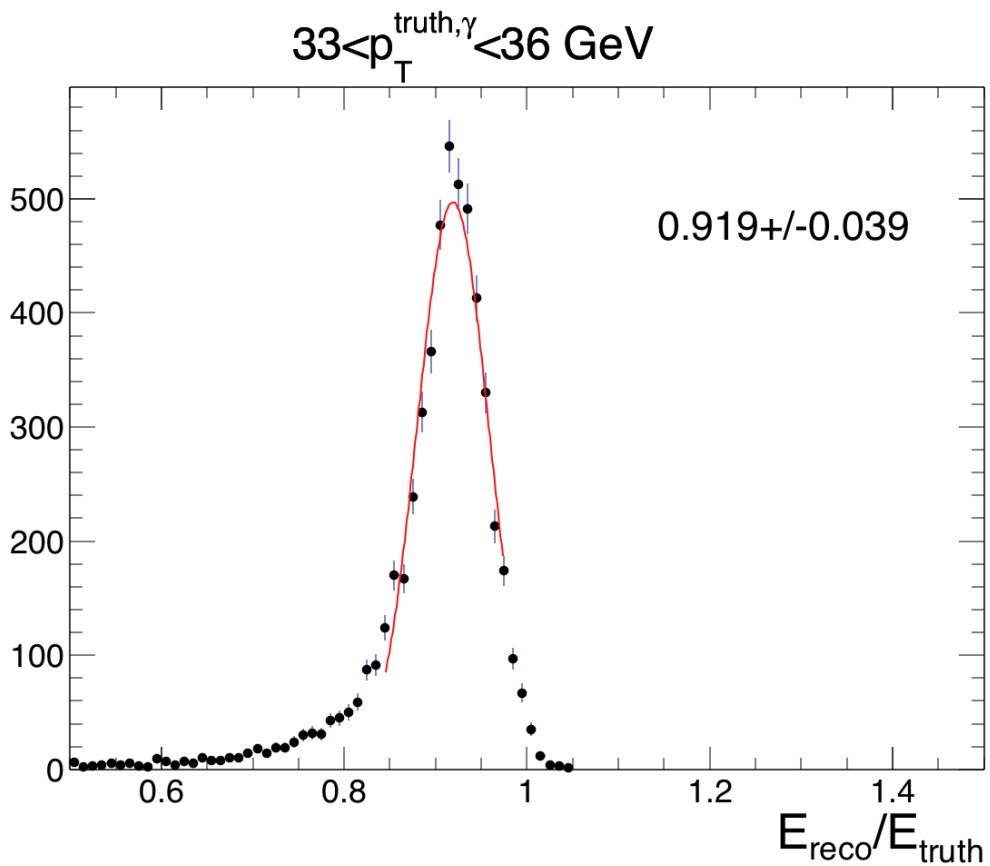
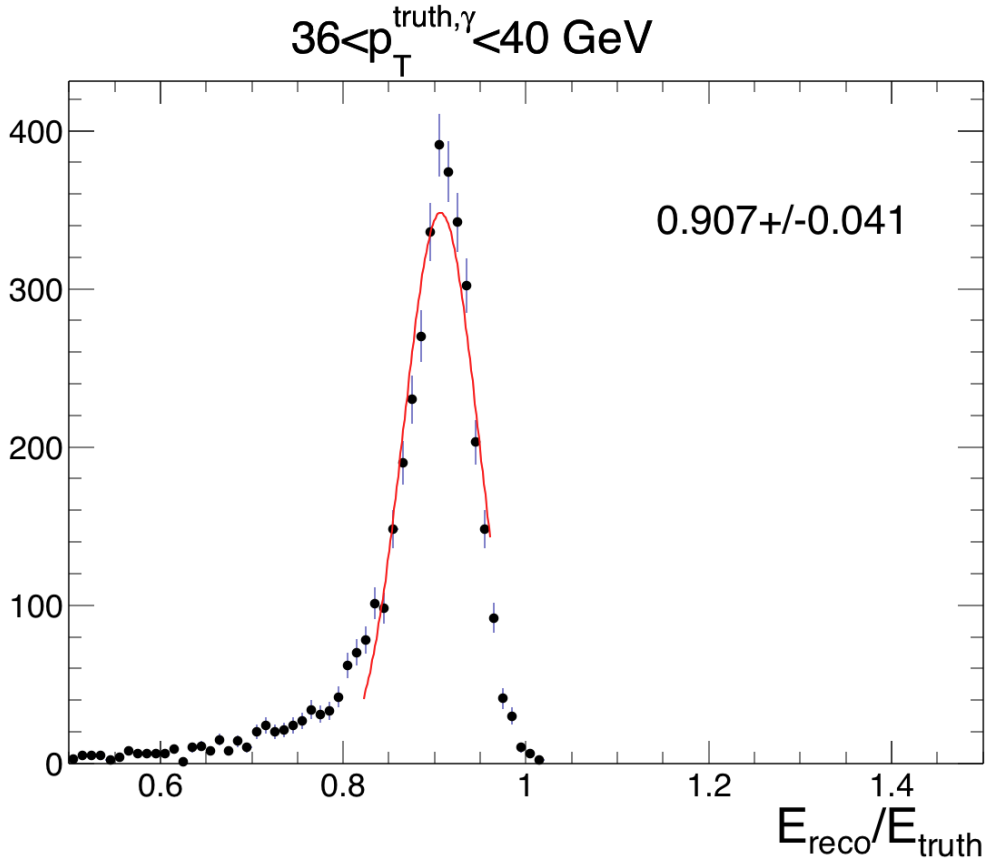
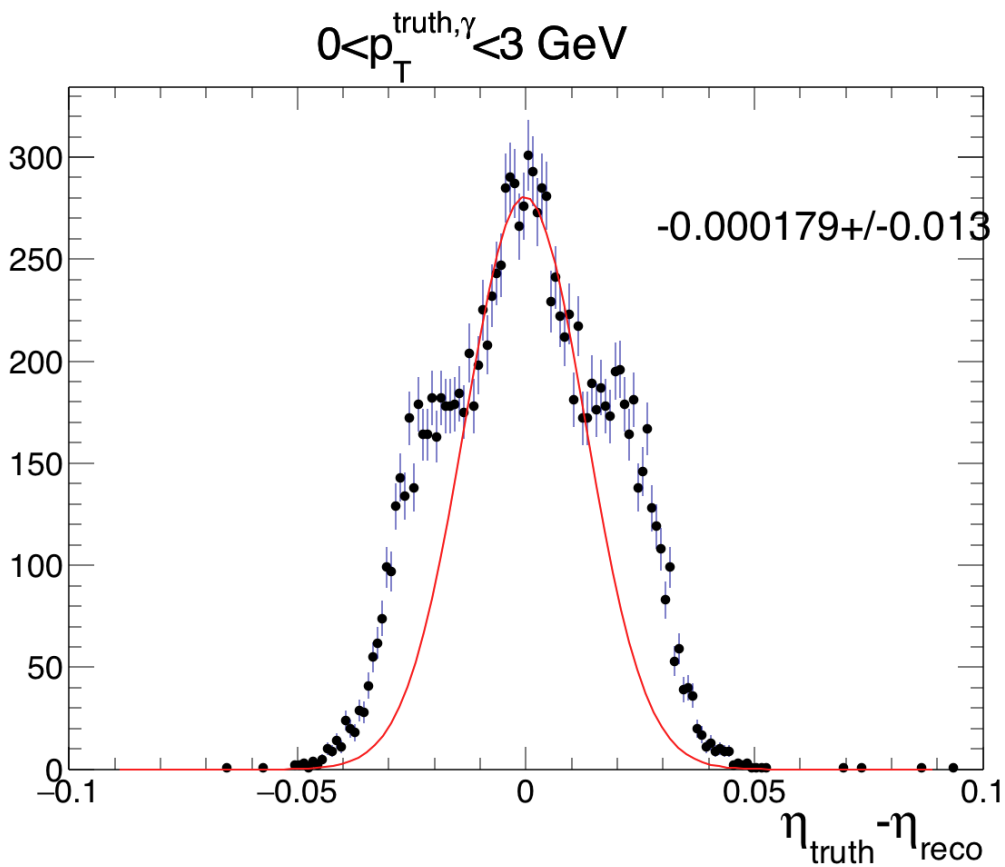
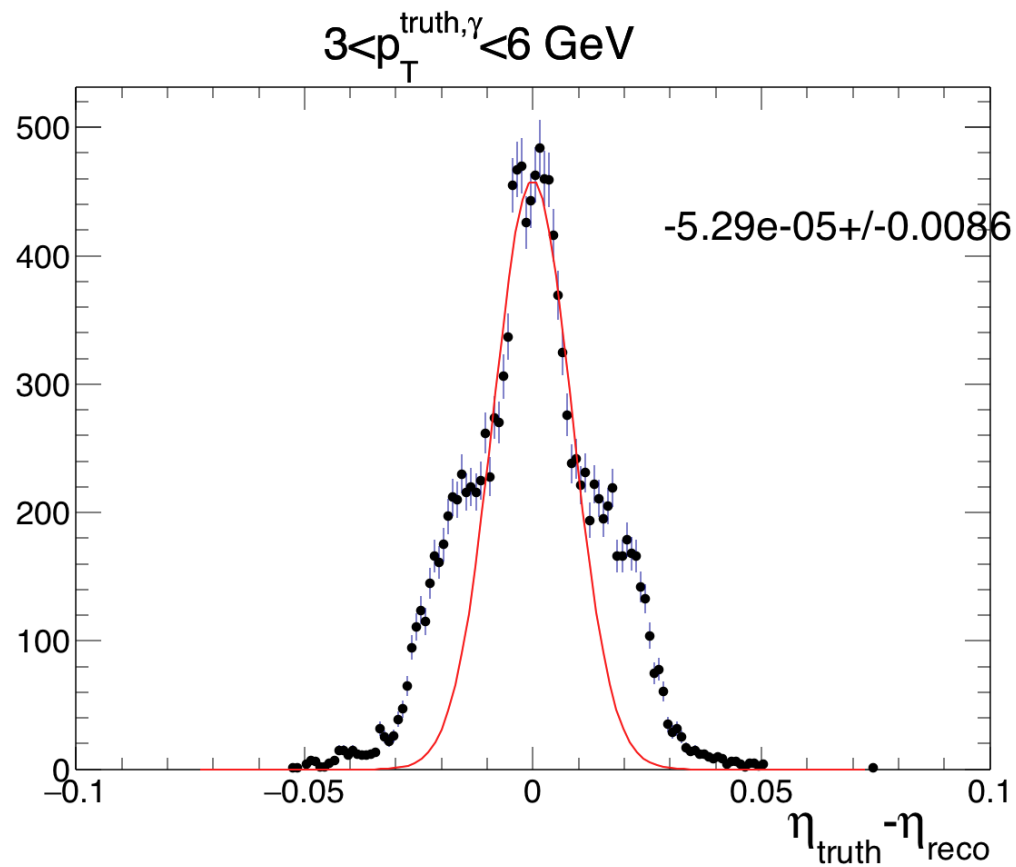
0.931+/-0.04
E_reco/E_truth


33<p_T^truth,γ<36 GeV
0.919+/-0.039
E_reco/E_truth


36<p_T^truth,γ<40 GeV
0.907+/-0.041
400
300
200
100
0
0.6
0.8
1
1.2
1.4
E_reco/E_truth


0<p_T^truth,γ<3 GeV
-0.000179+/-0.013
300
250
200
150
100
50
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco


3<p_T^truth,γ<6 GeV
-5.29e-05+/-0.0086
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400
300
200
100
0
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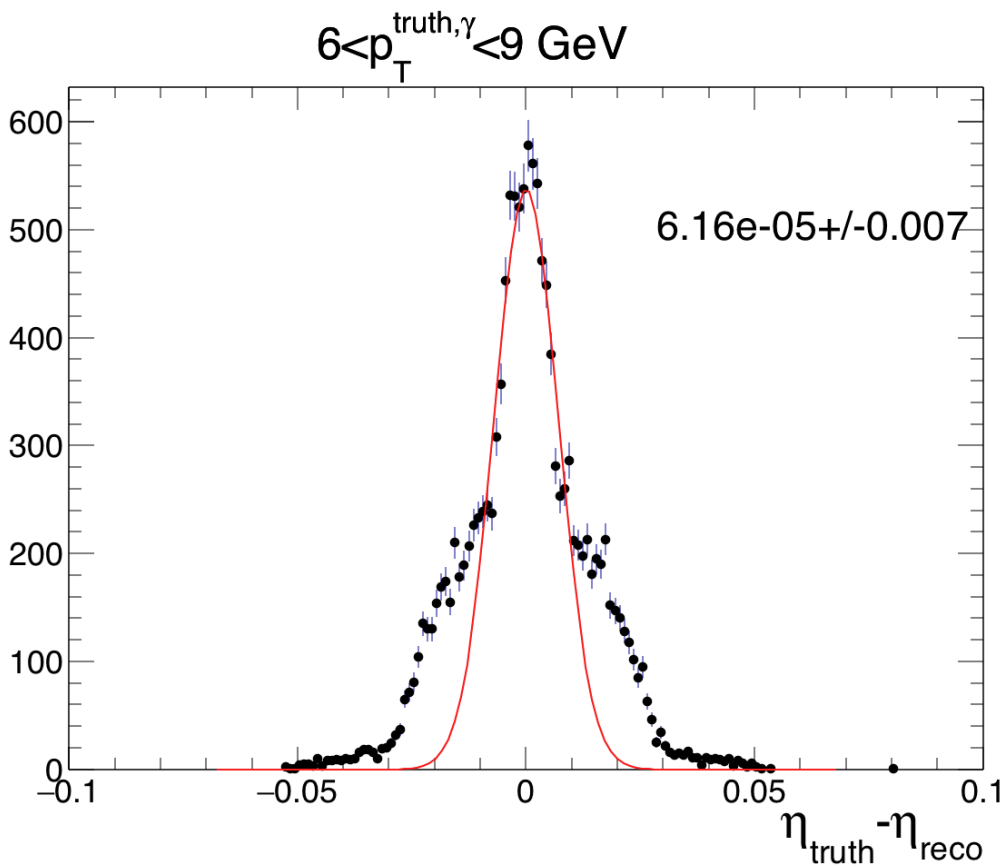
–0.05
0
0.05
0.1
η_truth-η_reco


6<p_T^truth,γ<9 GeV
6.16e-05+/-0.007
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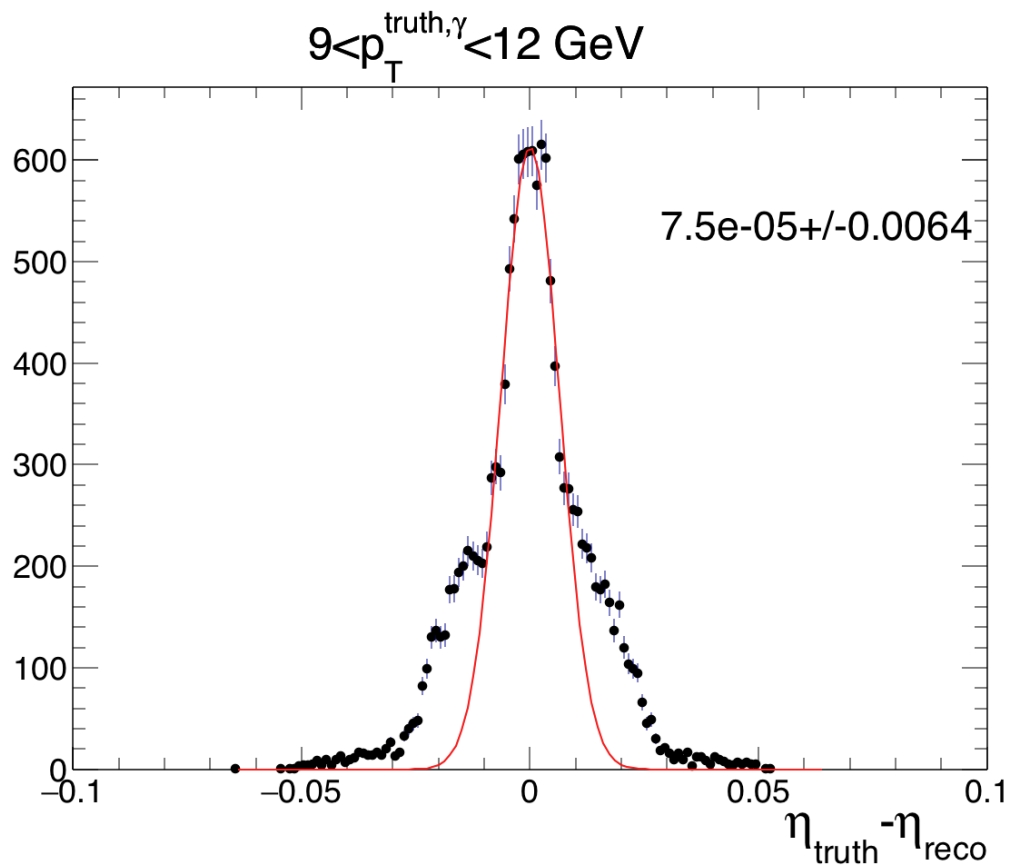
400
300
200
100
0
−0.1
−0.05
0
0.05
0.1
η_truth-η_reco


9<p_T^truth,γ<12 GeV
7.5e-05+/-0.0064
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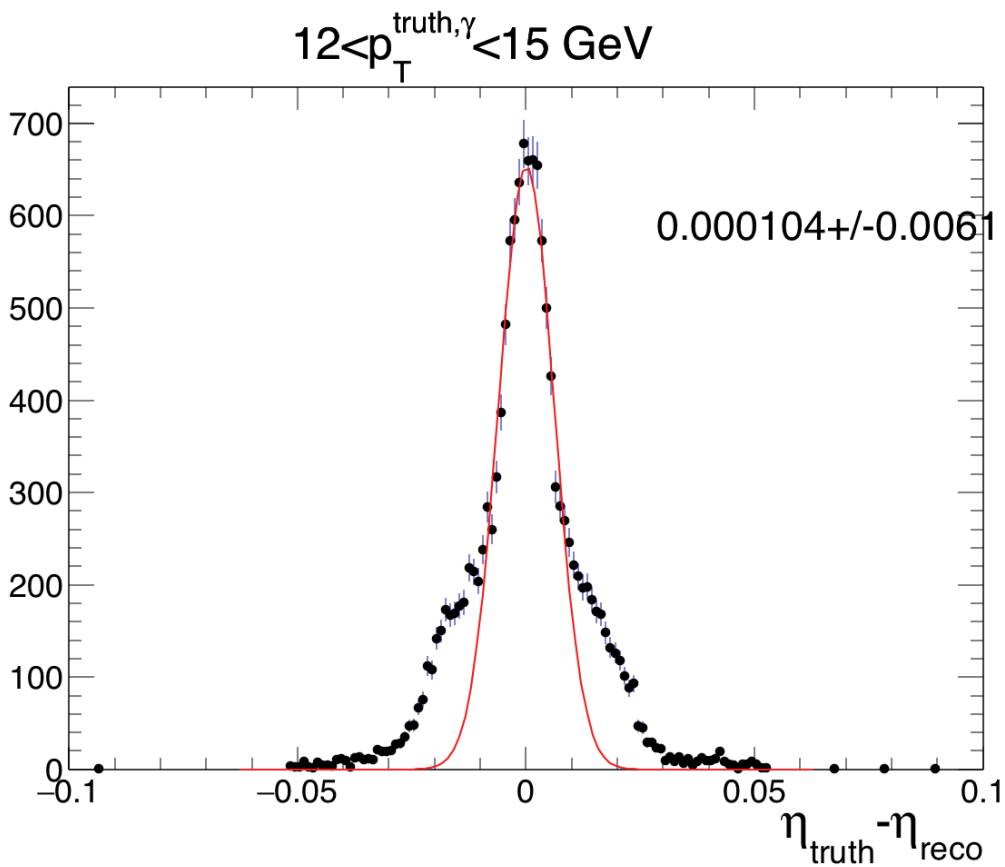
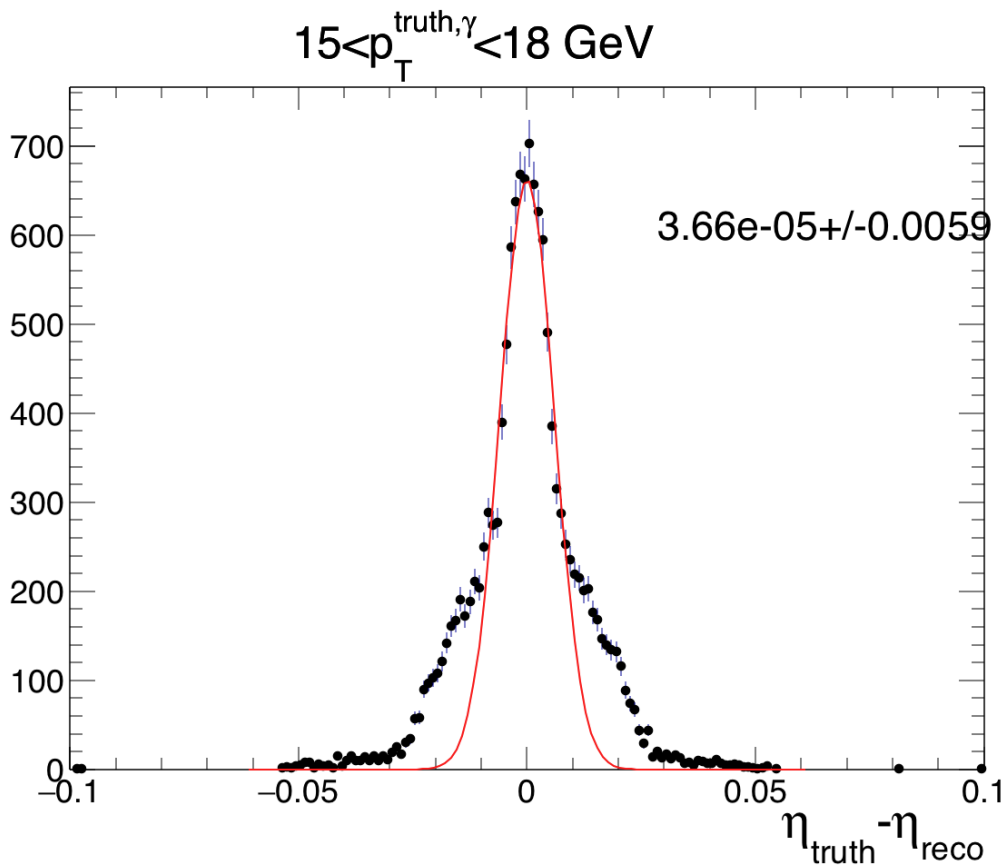
300
200
100
0
−0.1
−0.05
0
0.05
0.1
η_truth-η_reco


12<p_T^truth,γ<15 GeV
0.000104+/-0.0061
700
600
500
400
300
200
100
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco


15<p_T^truth,γ<18 GeV
3.66e-05+/-0.0059
700
600
500
400
300
200
100
0
–0.1
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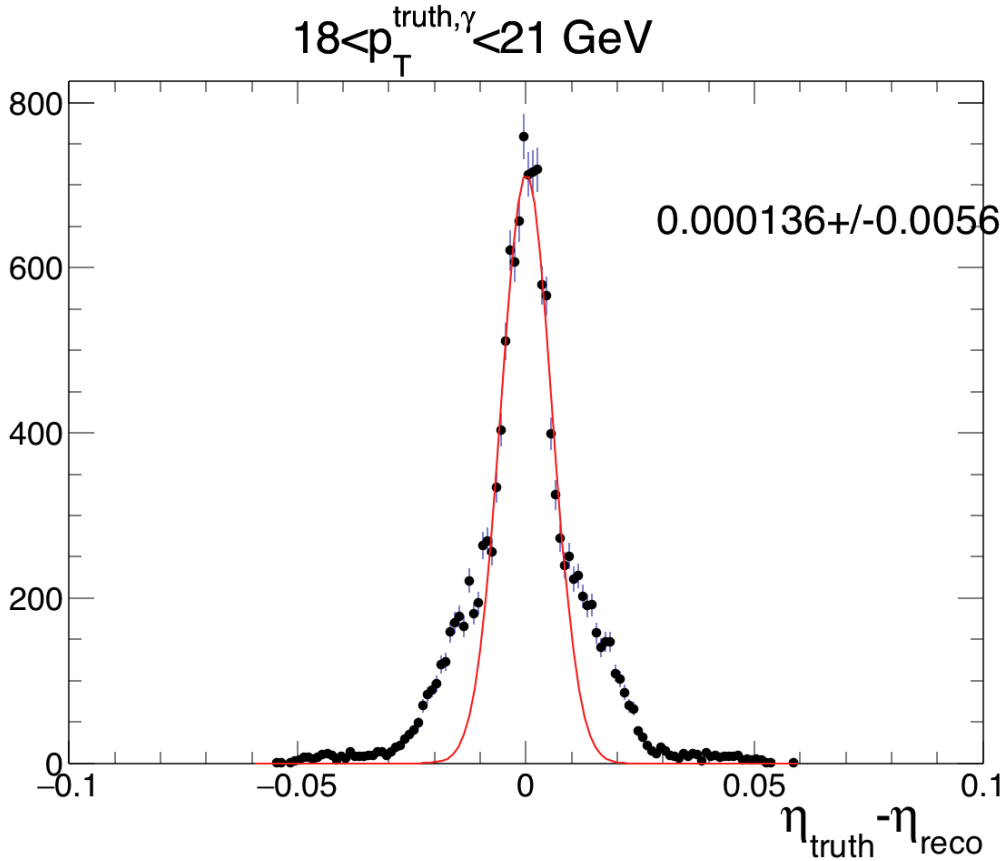
0
0.05
0.1
η_truth-η_reco


18<p_T^truth,γ<21 GeV
0.000136+/-0.0056
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600
400
200
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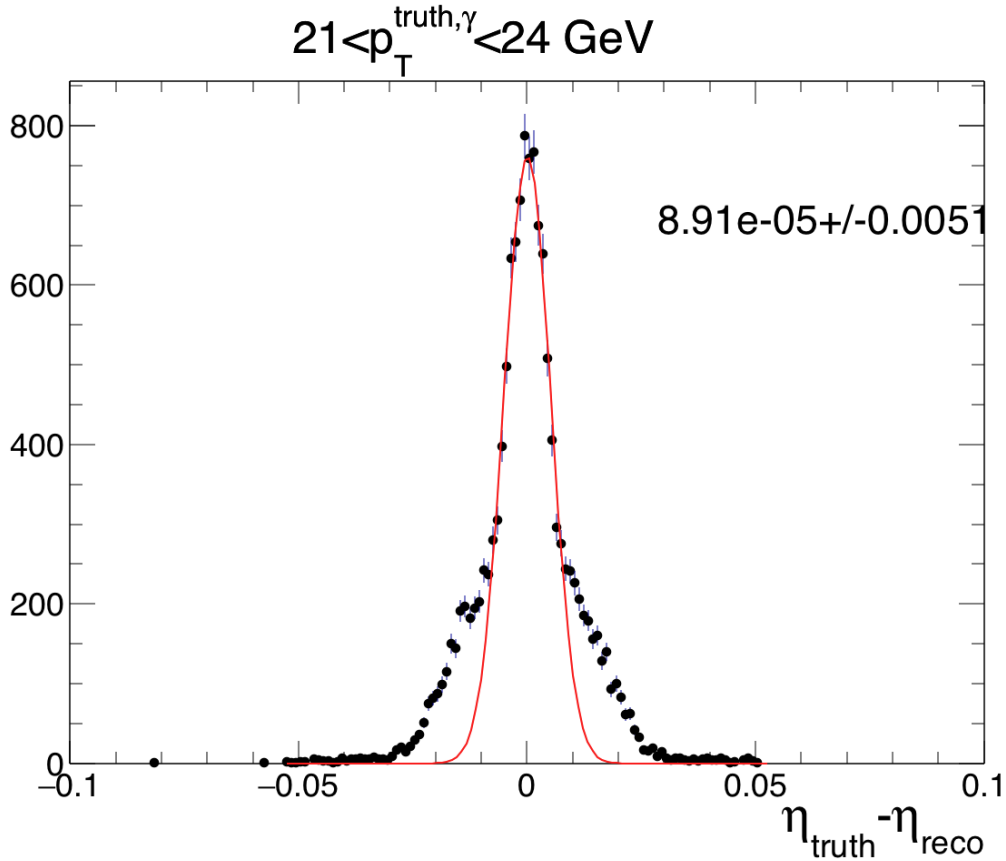
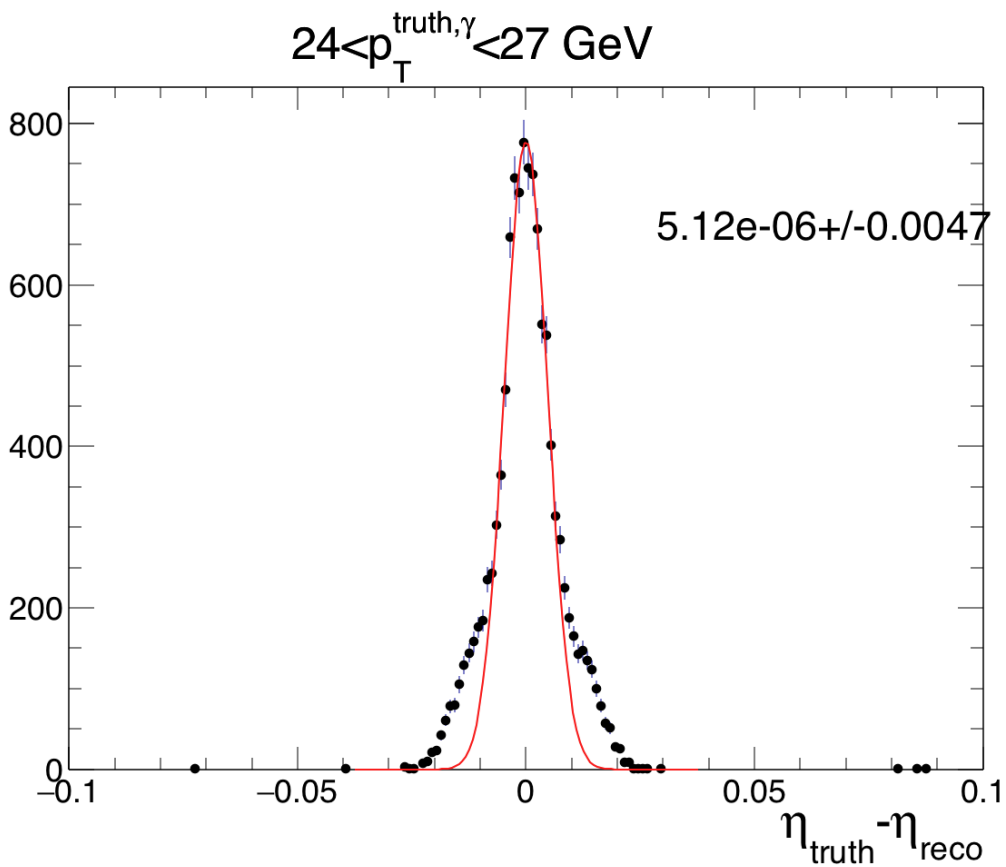
–0.05
0
0.05
0.1
η_truth-η_reco


21<p_T^truth,γ<24 GeV
8.91e-05+/-0.0051
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco


24<p_T^truth,γ<27 GeV
5.12e-06+/-0.0047
800
600
400
200
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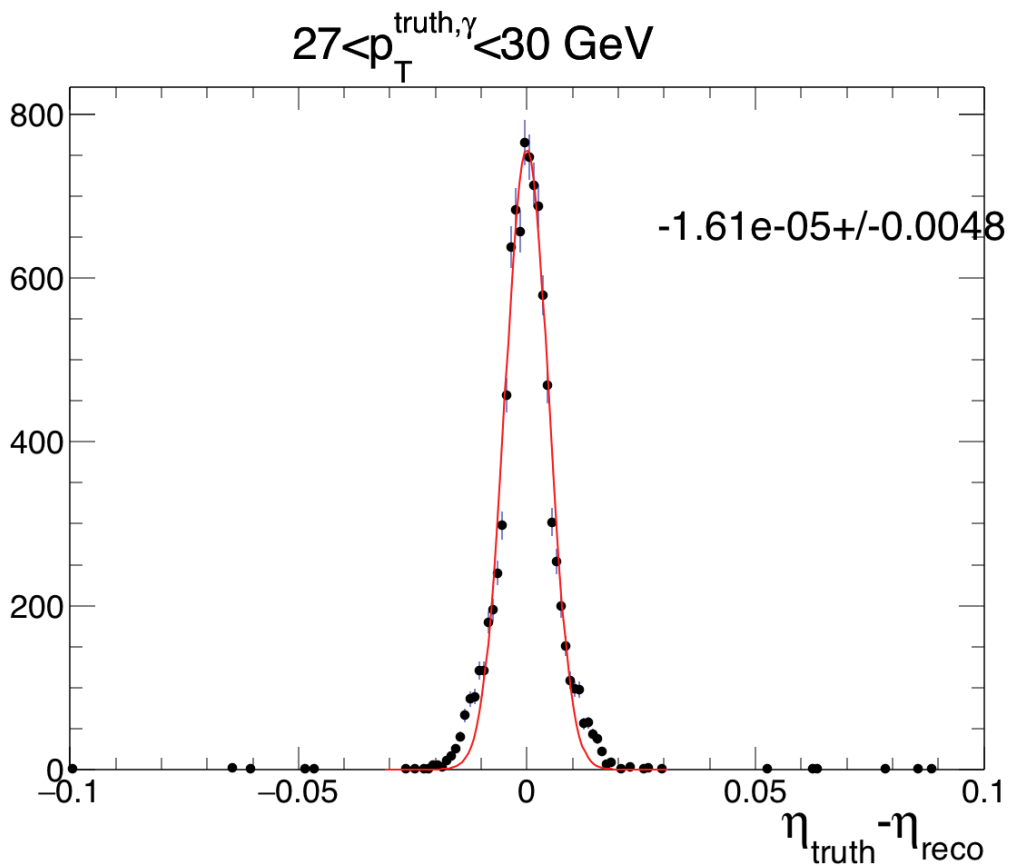
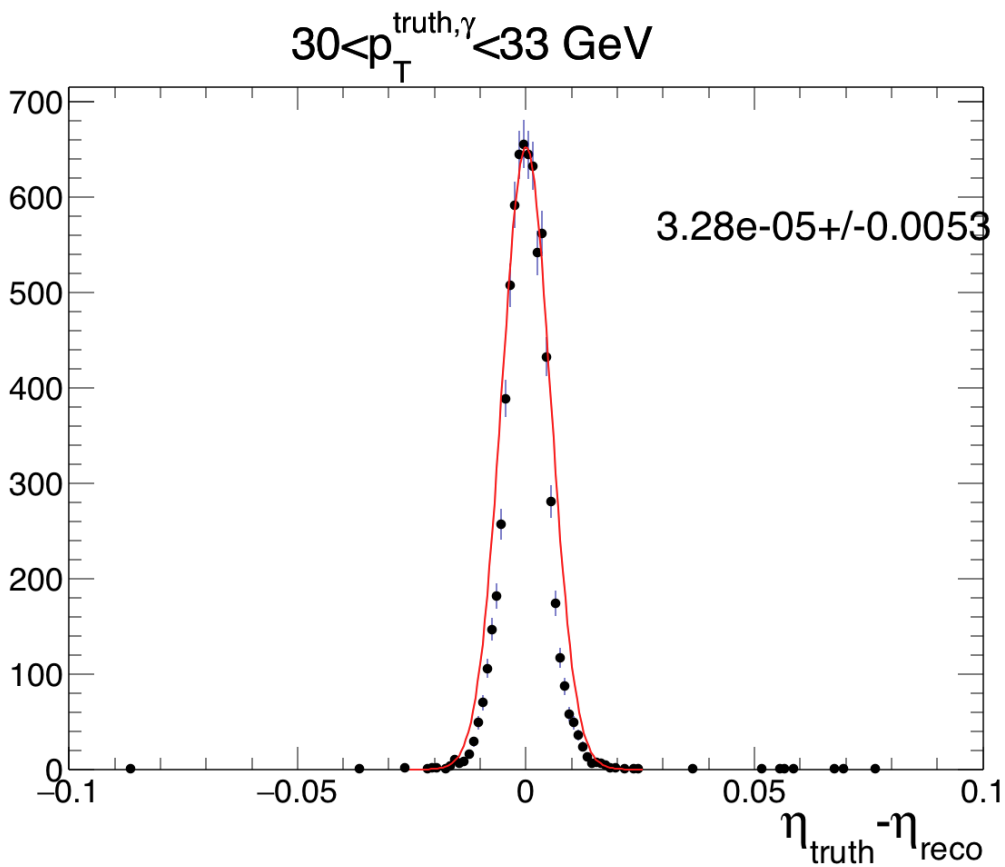
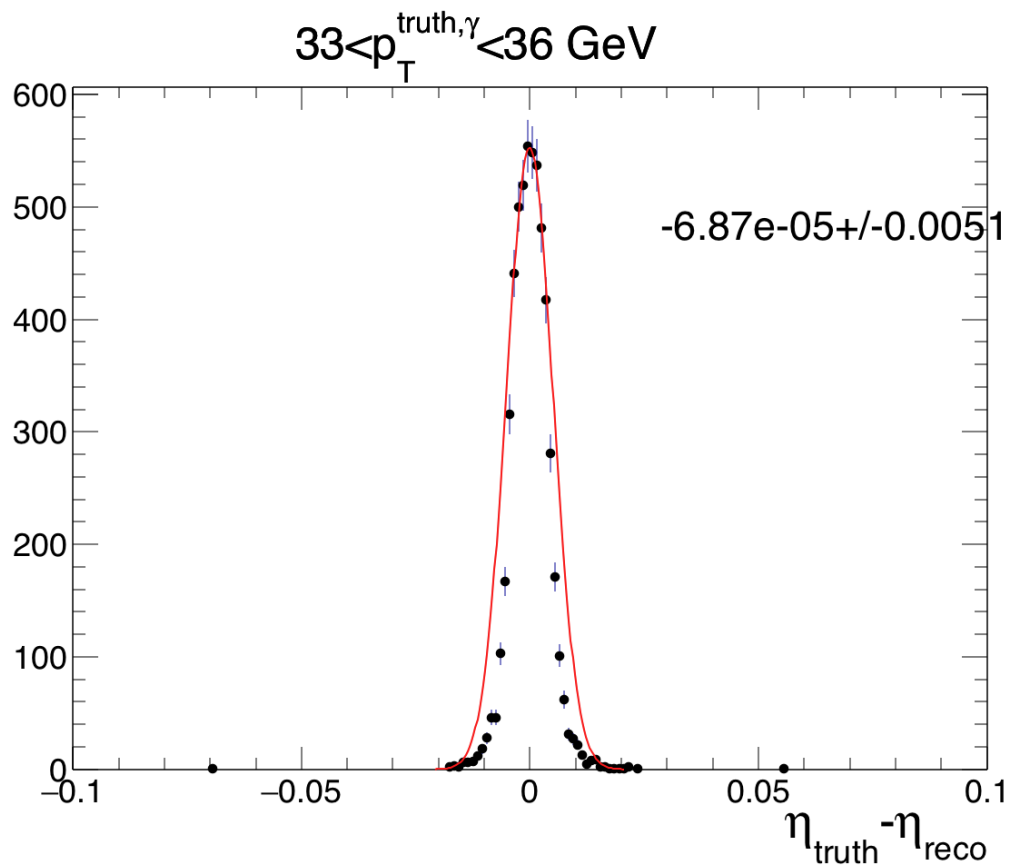
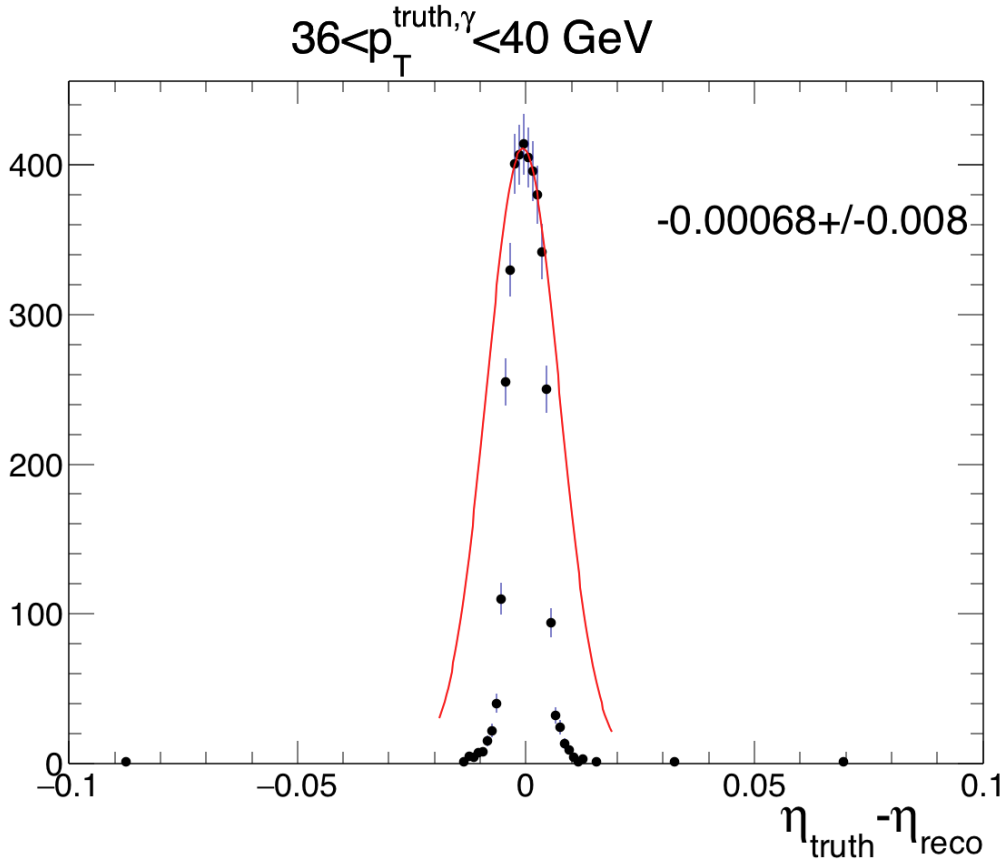
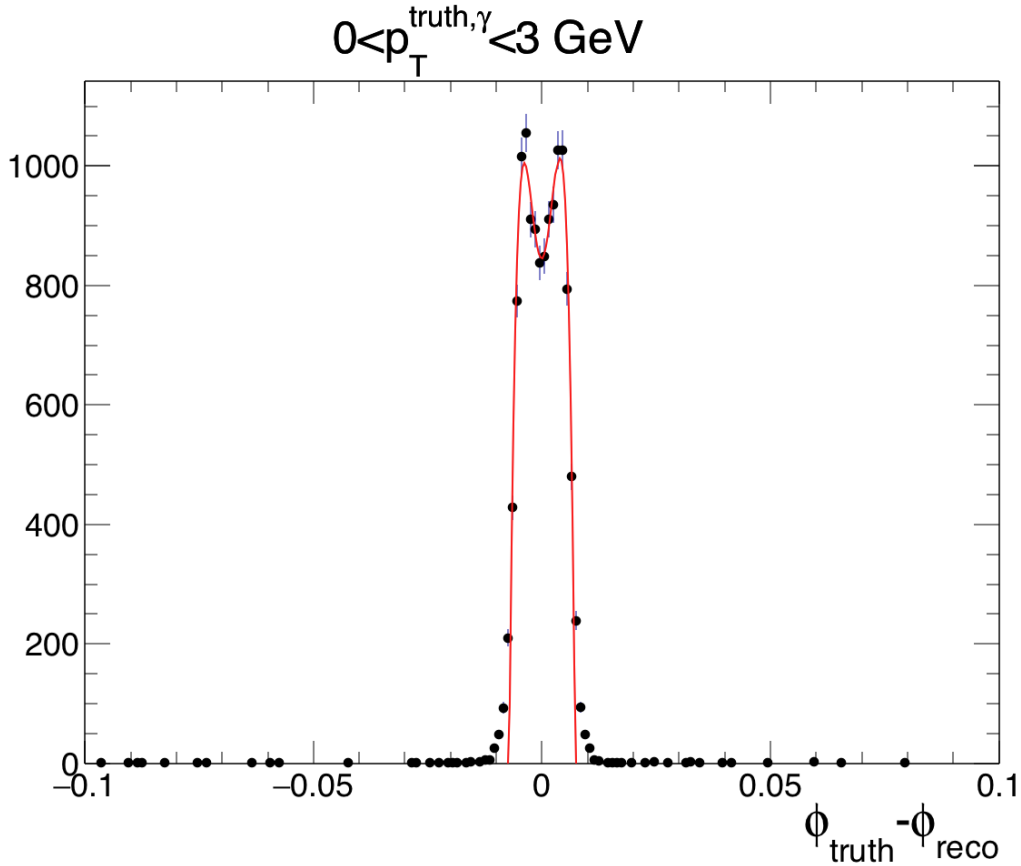
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco

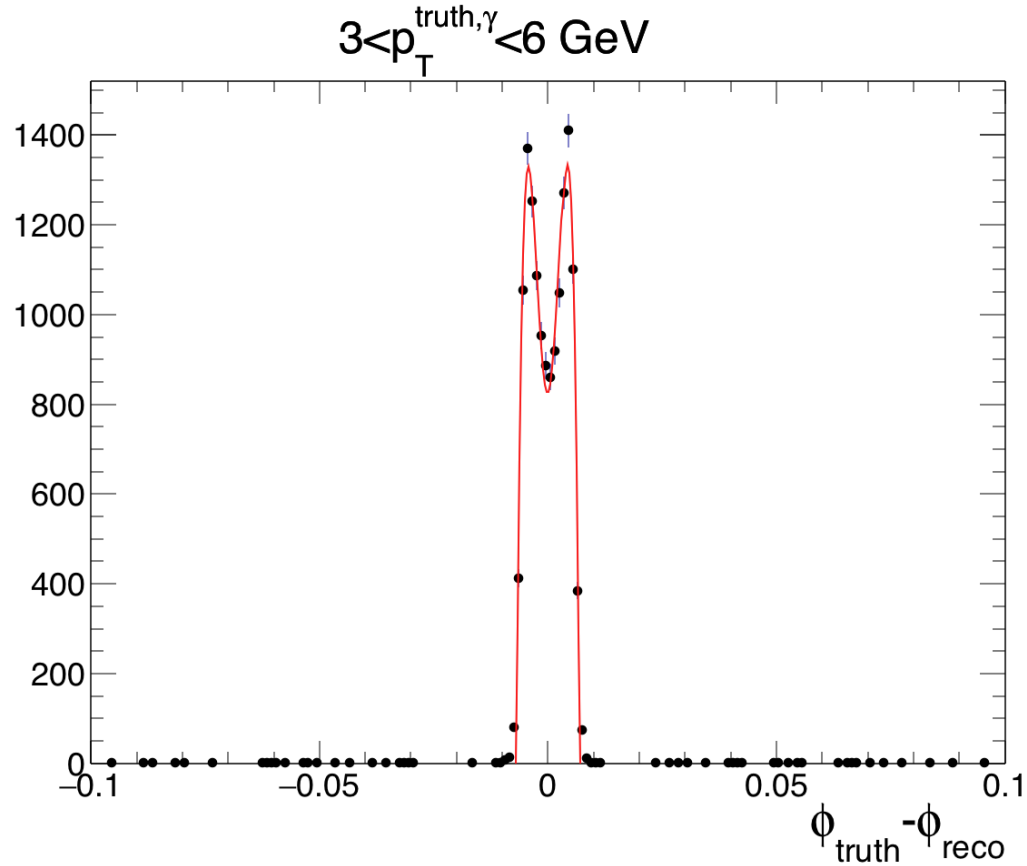

27<p_T^truth,γ<30 GeV
-1.61e-05+/-0.0048
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco

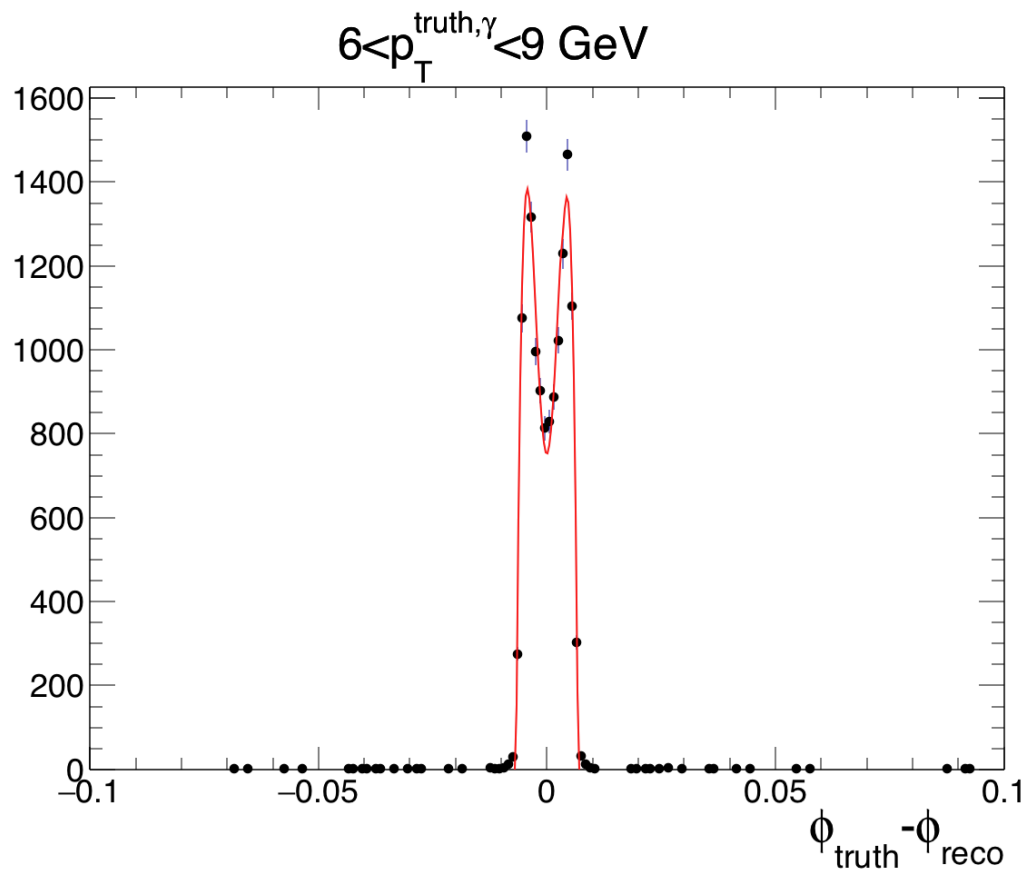

30<p_T^truth,γ<33 GeV
3.28e-05+/-0.0053
700
600
500
400
300
200
100
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco

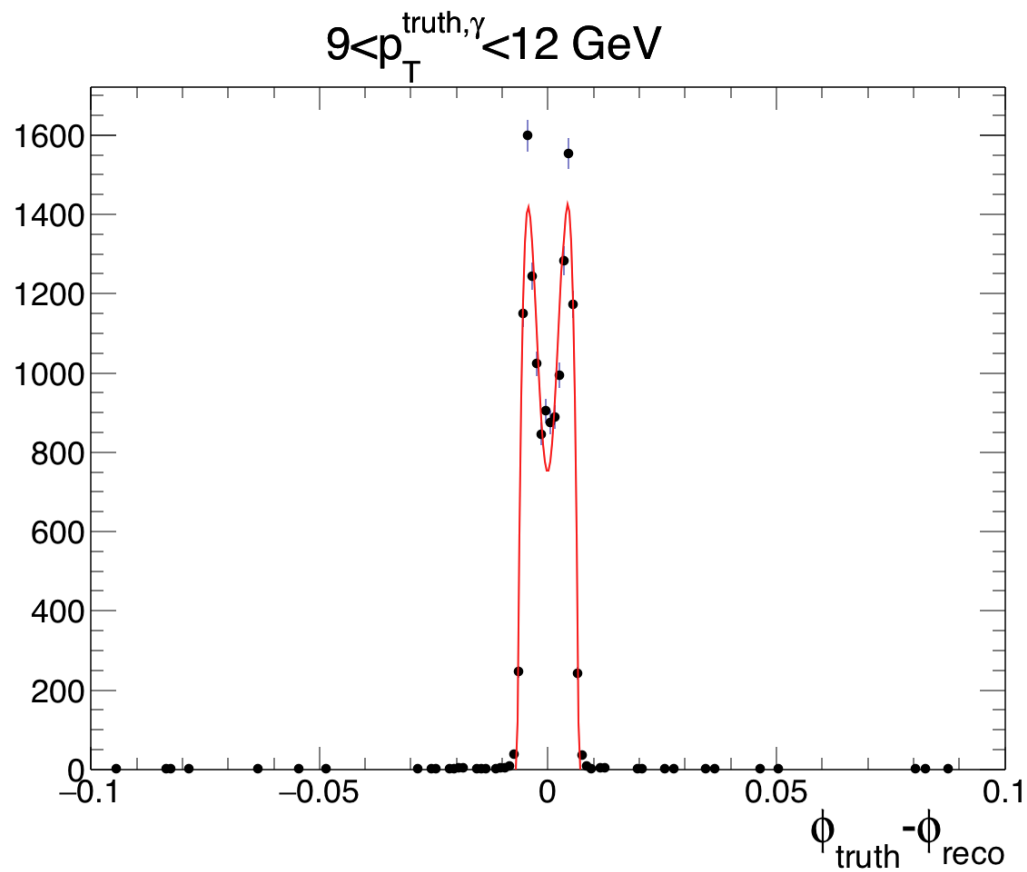

33<p_T^truth,γ<36 GeV
-6.87e-05+/-0.0051
600
500
400
300
200
100
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco

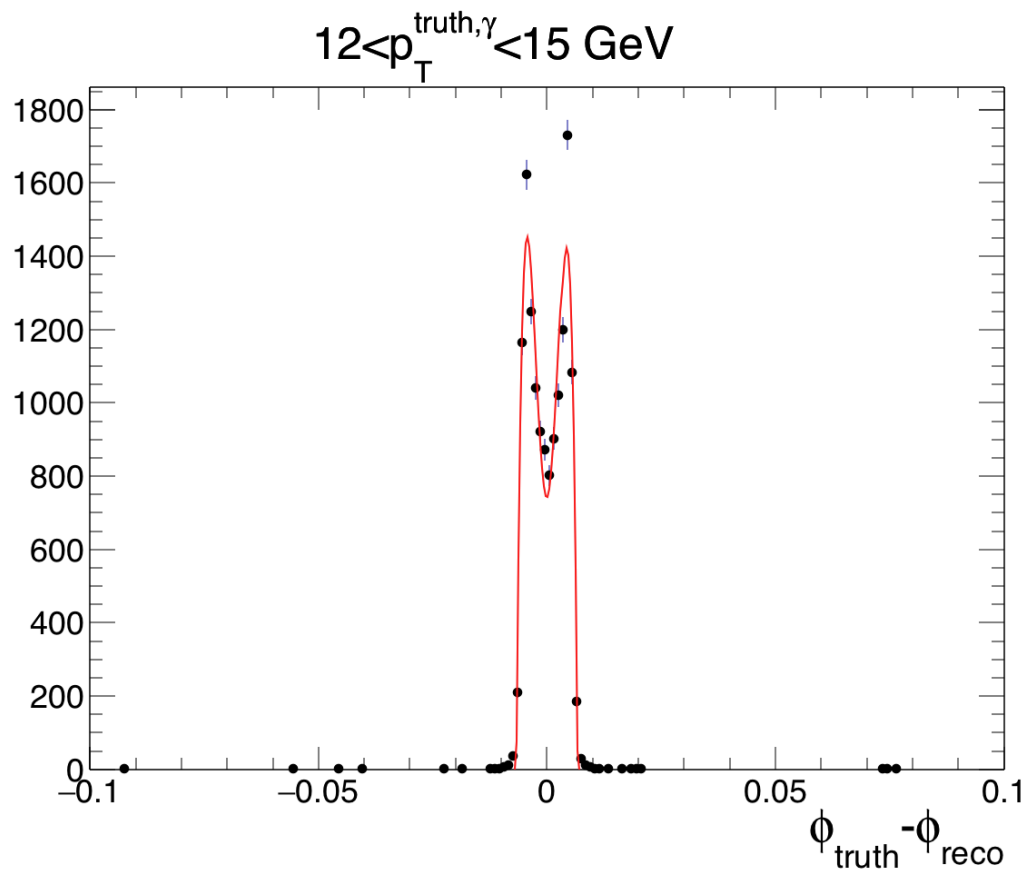

36<p_T^truth,γ<40 GeV
-0.00068+/-0.008
400
300
200
100
0
–0.1
–0.05
0
0.05
0.1
η_truth-η_reco

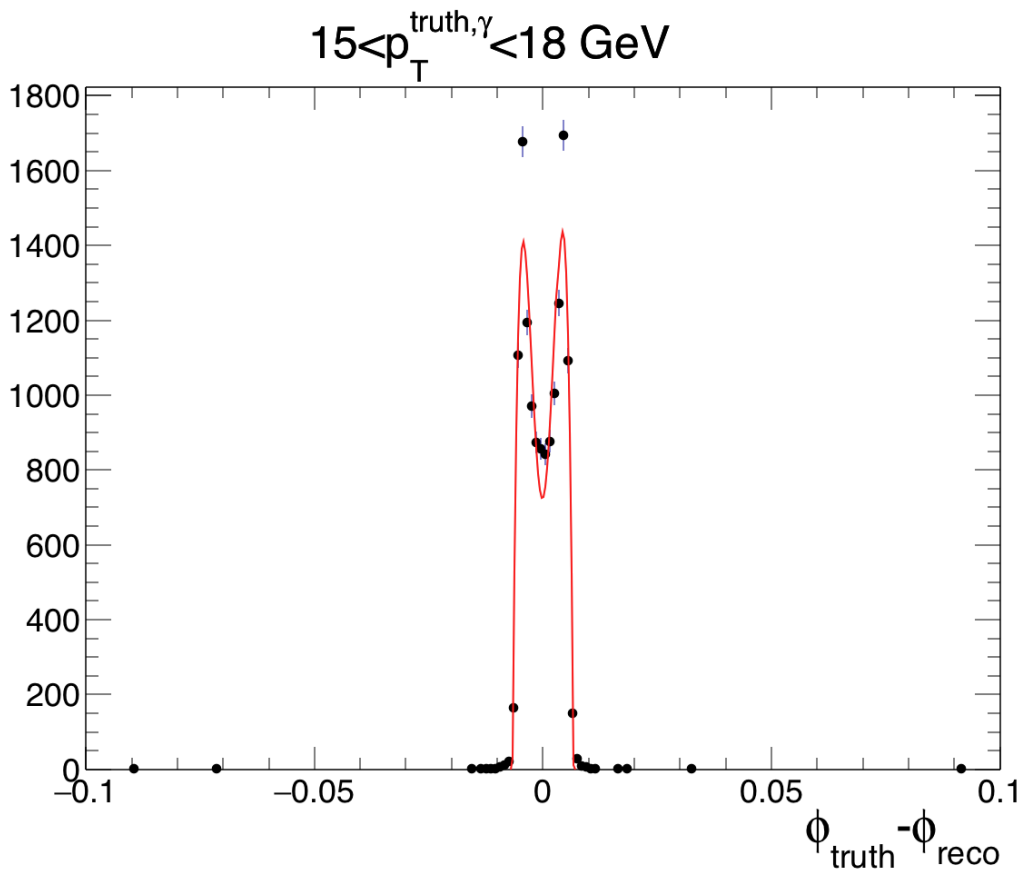

$0<p_T^{truth,\gamma}<3$ GeV
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
$\phi_{truth}-\phi_{reco}$

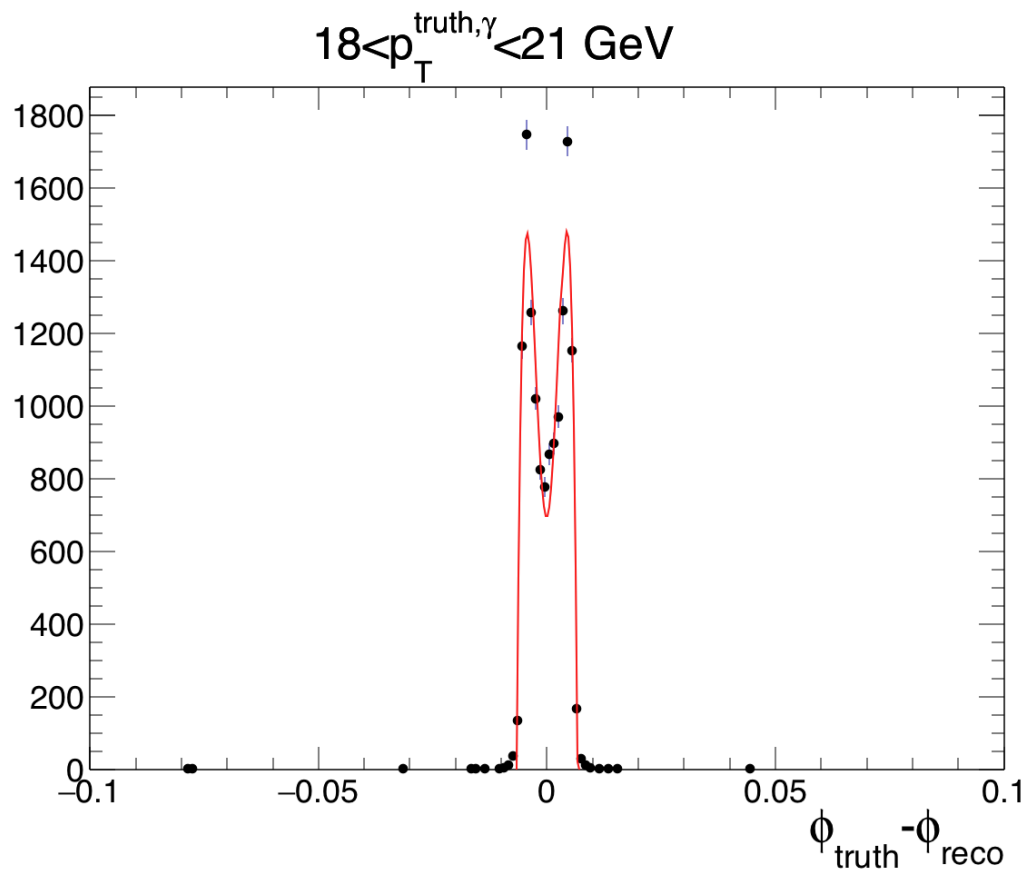

$3<p_T^{truth,\gamma}<6$ GeV
1400
1200
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
$\phi_{truth}-\phi_{reco}$

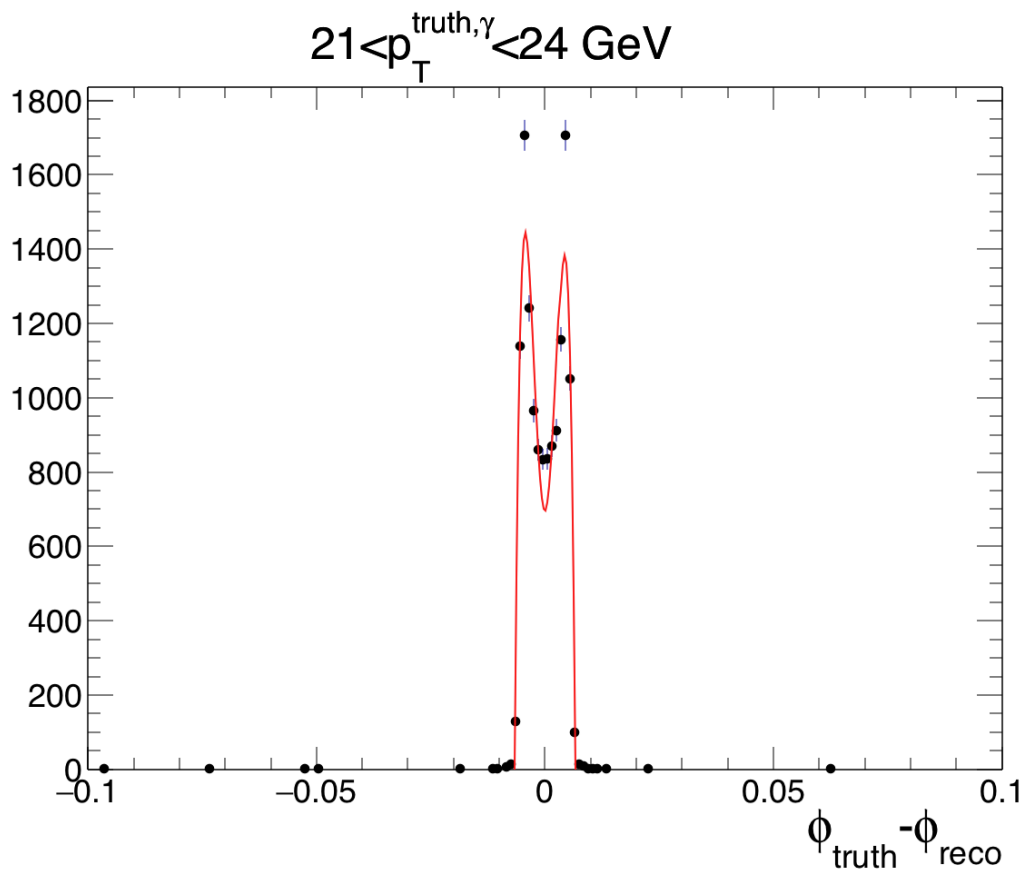

6<p_T^truth,γ<9 GeV
1600
1400
1200
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

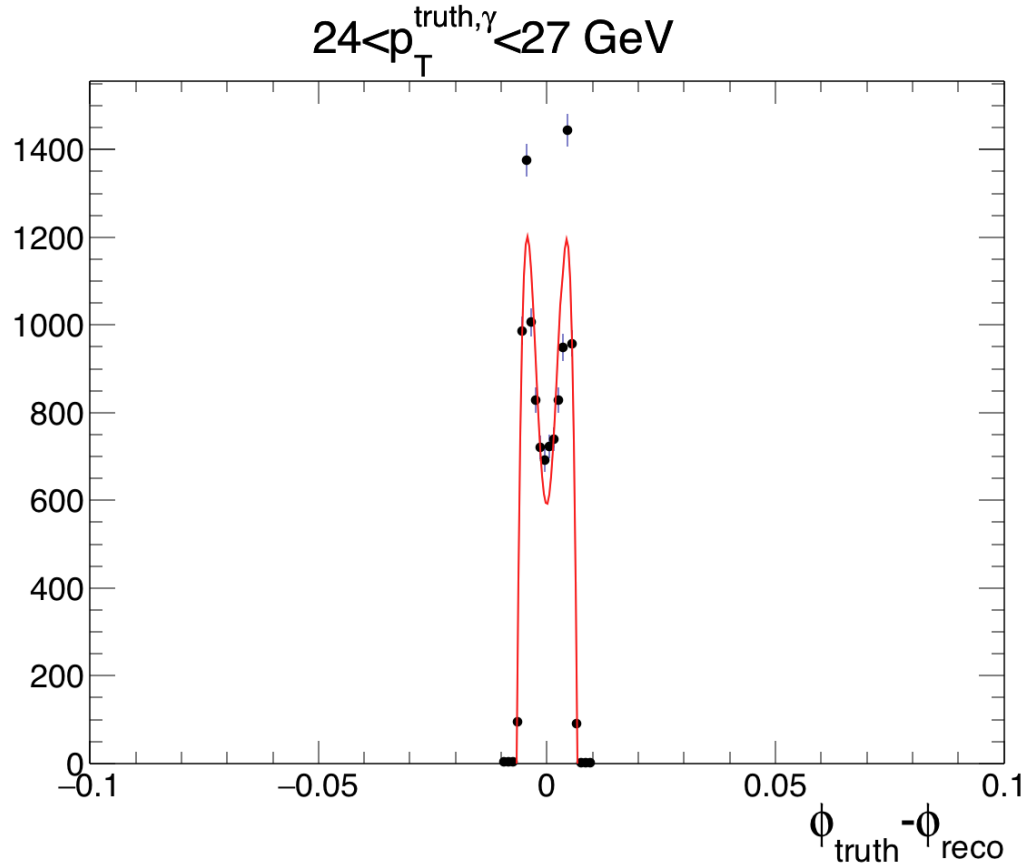

9<p_T^truth,γ<12 GeV
1600
1400
1200
1000
800
600
400
200
0
−0.1
−0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

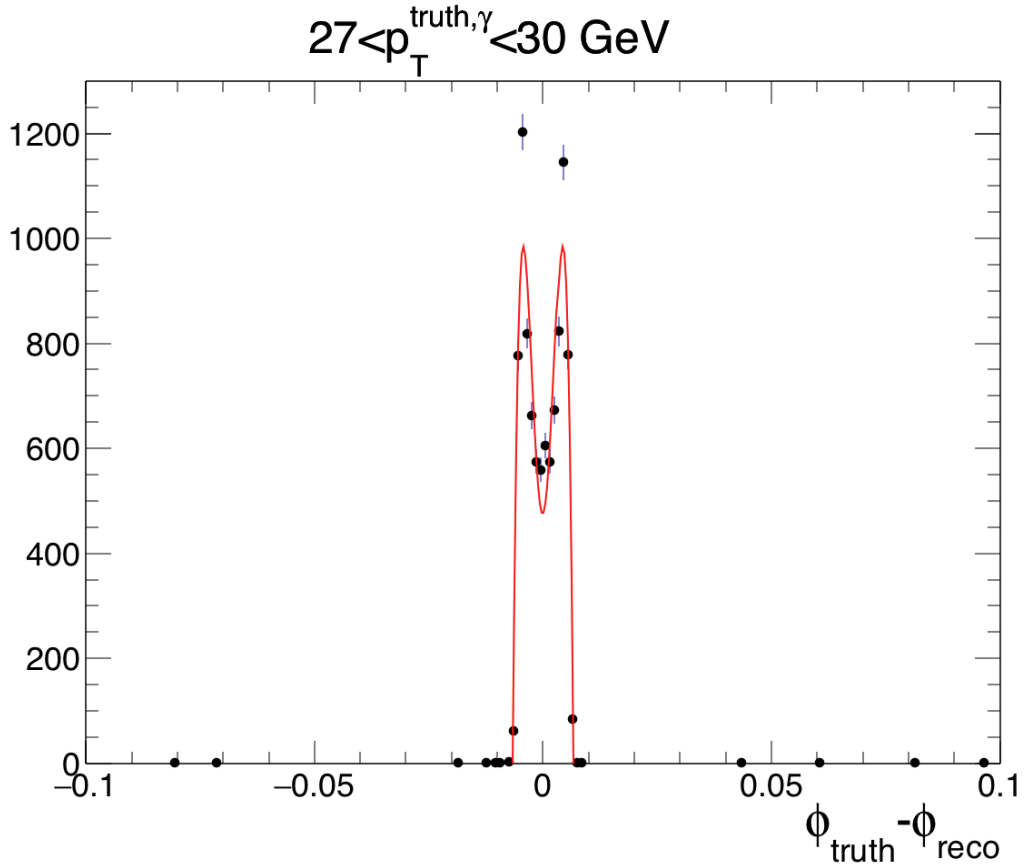

12<p_T^truth,γ<15 GeV
1800
1600
1400
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

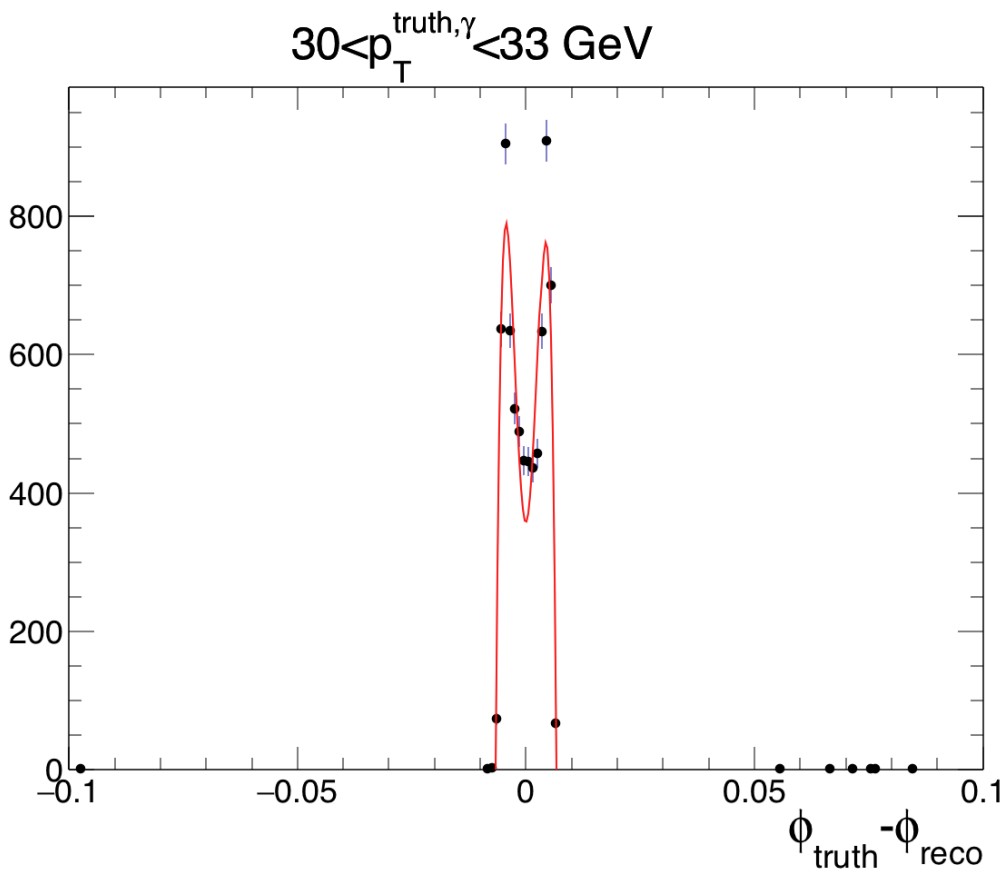

15<p_T^truth,γ<18 GeV
1800
1600
1400
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

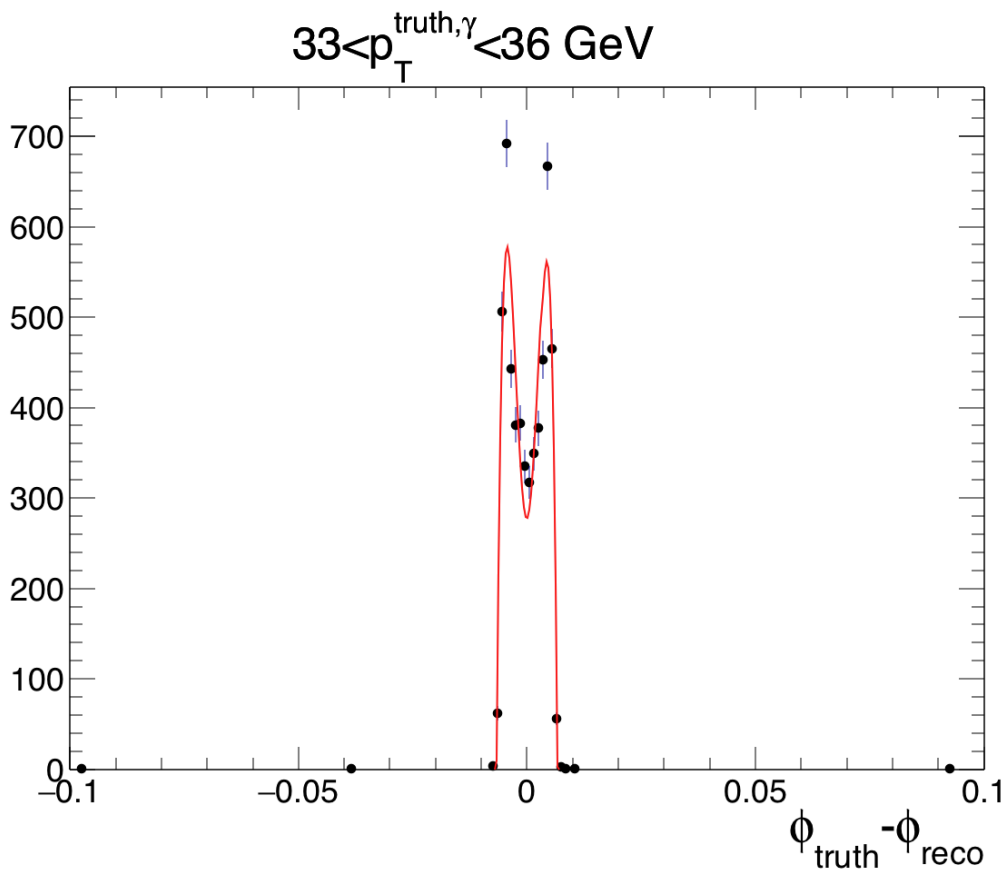

18<p_T^truth,γ<21 GeV
1800
1600
1400
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

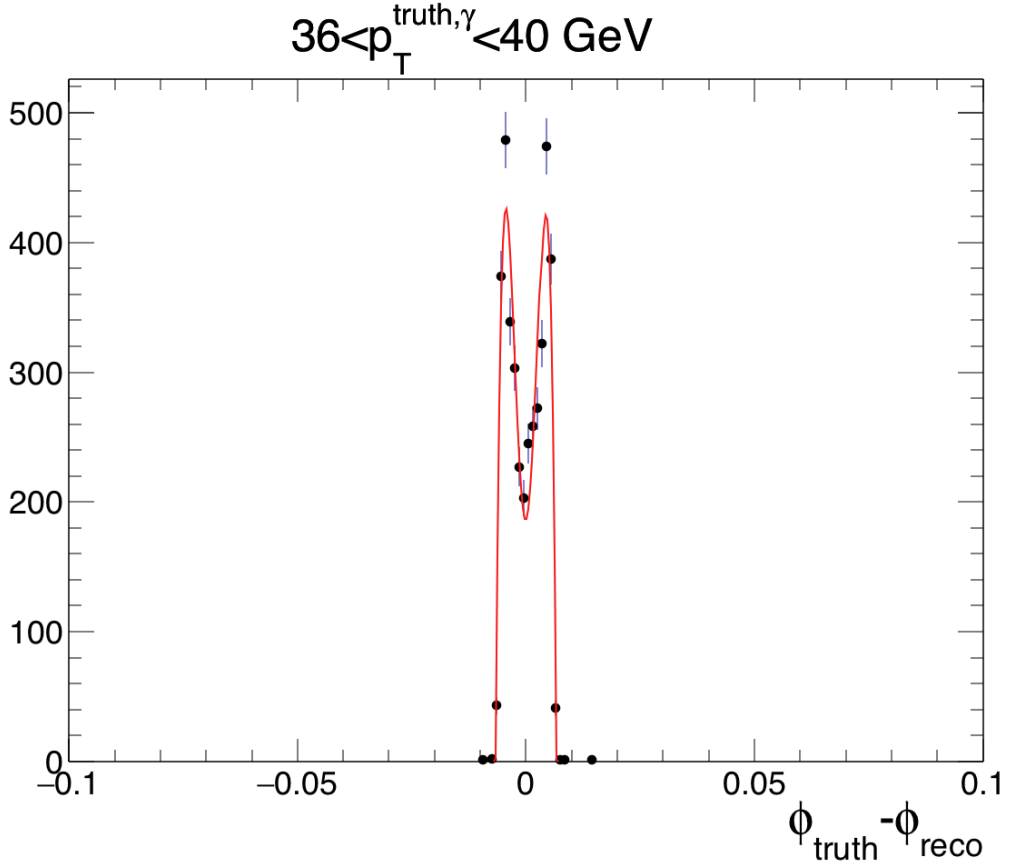

21<p_T^truth,γ<24 GeV
1800
1600
1400
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

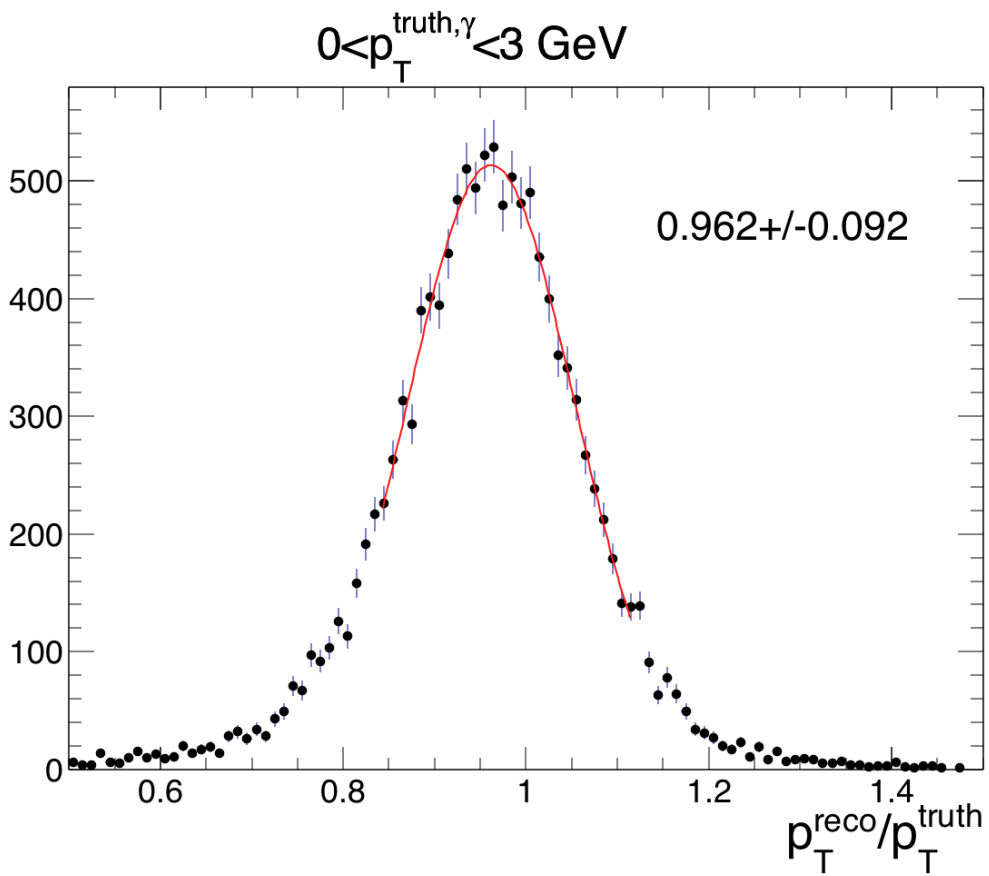

24<p_T^truth,γ<27 GeV
1400
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

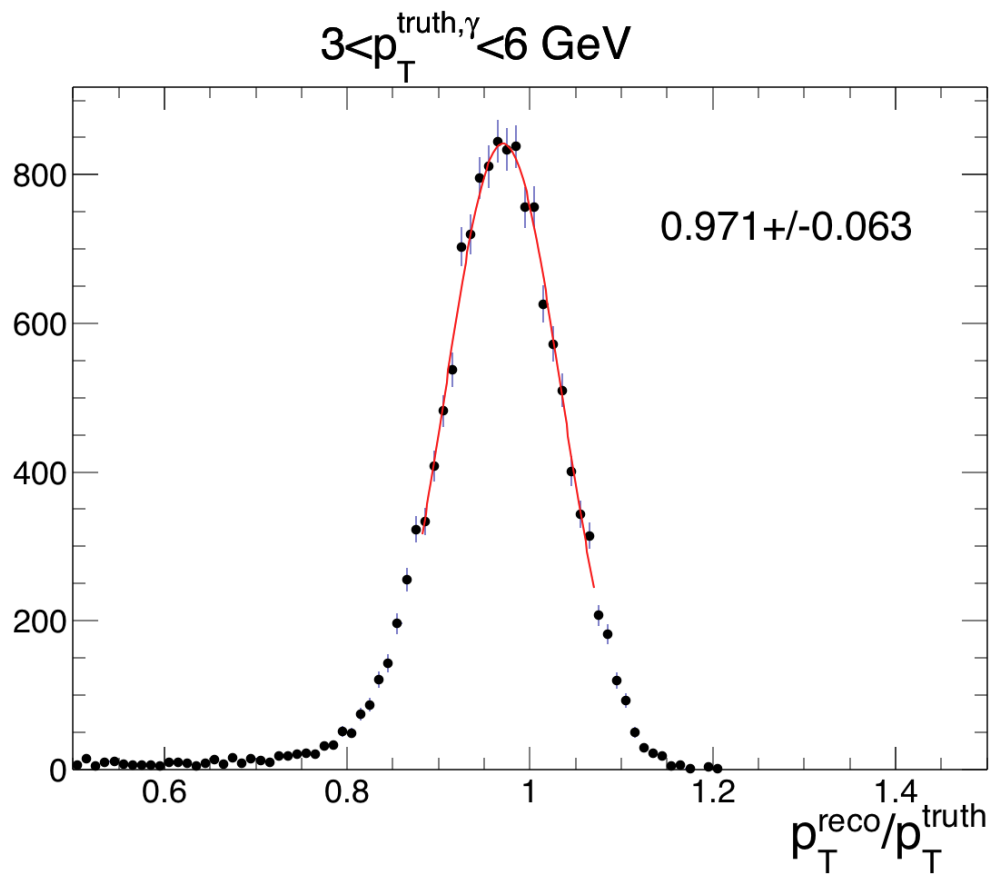

27<p_T^truth,γ<30 GeV
1200
1000
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

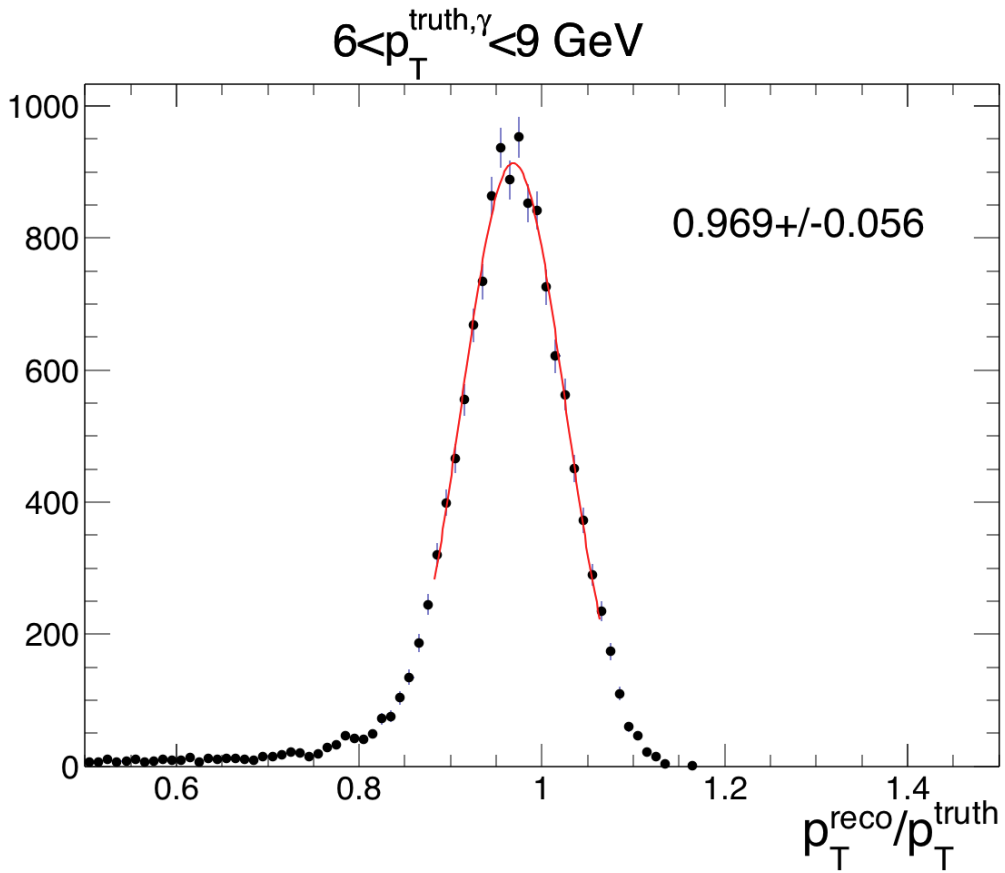

30<p_T^truth,γ<33 GeV
800
600
400
200
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

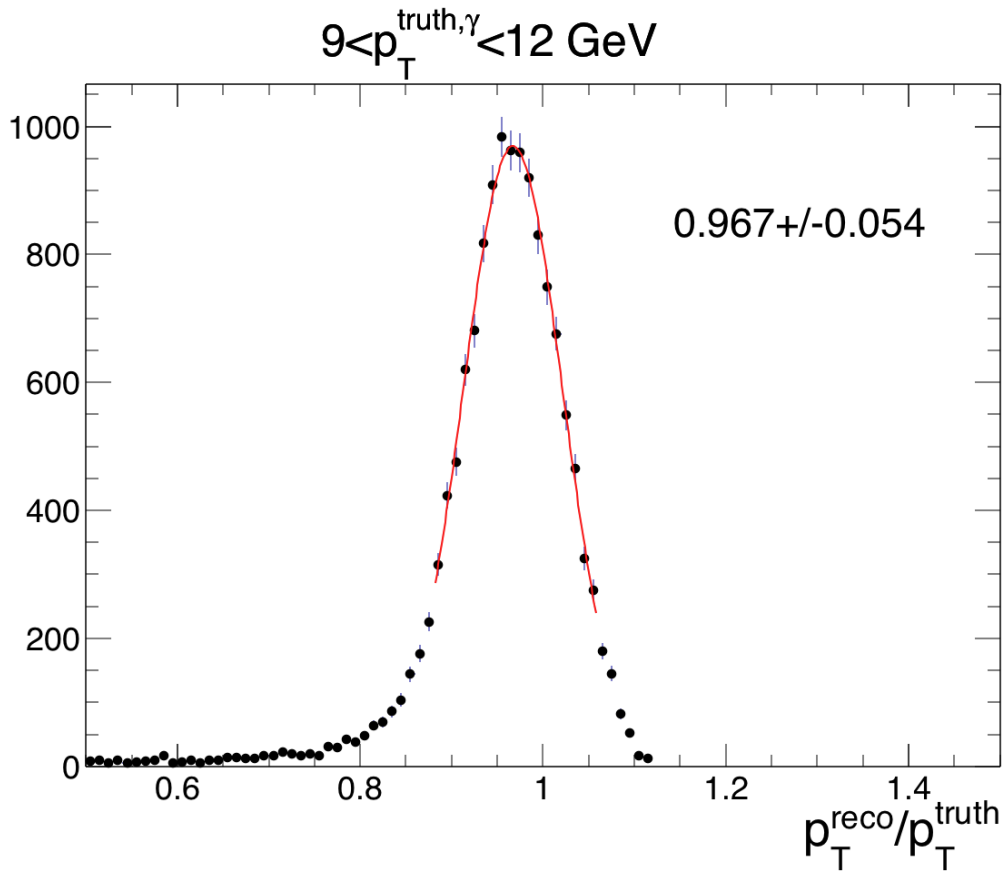

33<p_T^truth,γ<36 GeV
700
600
500
400
300
200
100
0
–0.1
–0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

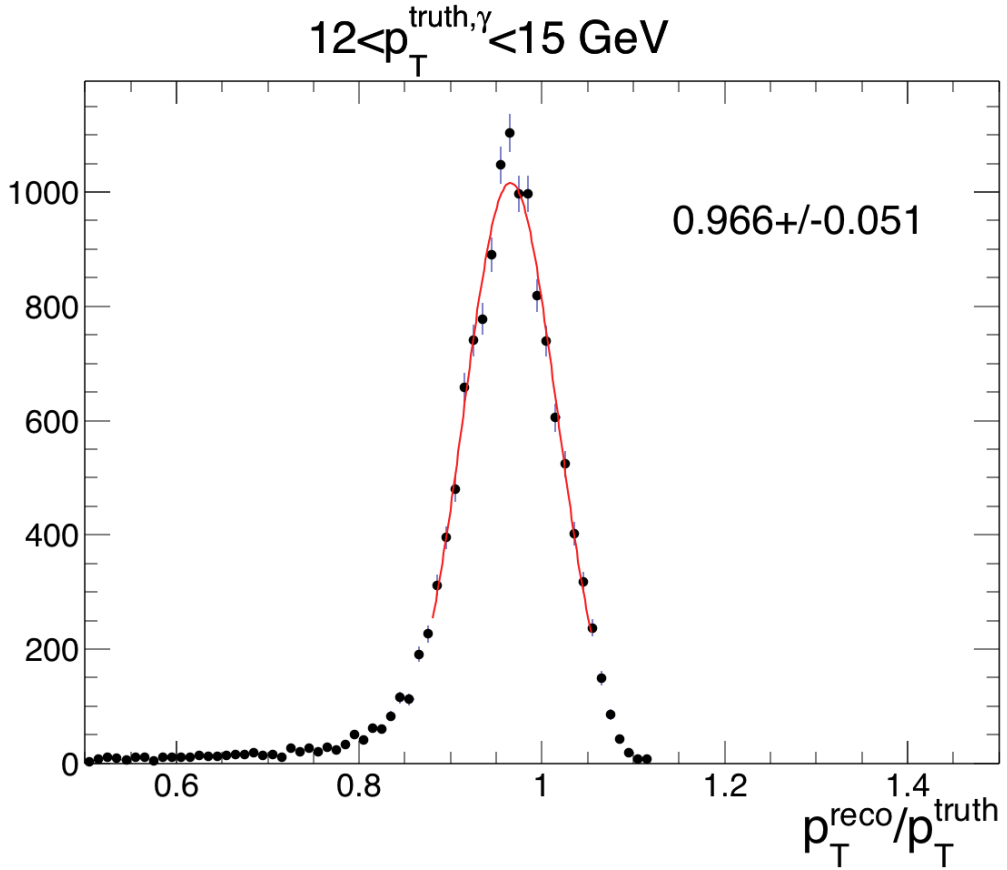

36<p_T^truth,γ<40 GeV
500
400
300
200
100
0
−0.1
−0.05
0
0.05
0.1
ϕ_truth -ϕ_reco

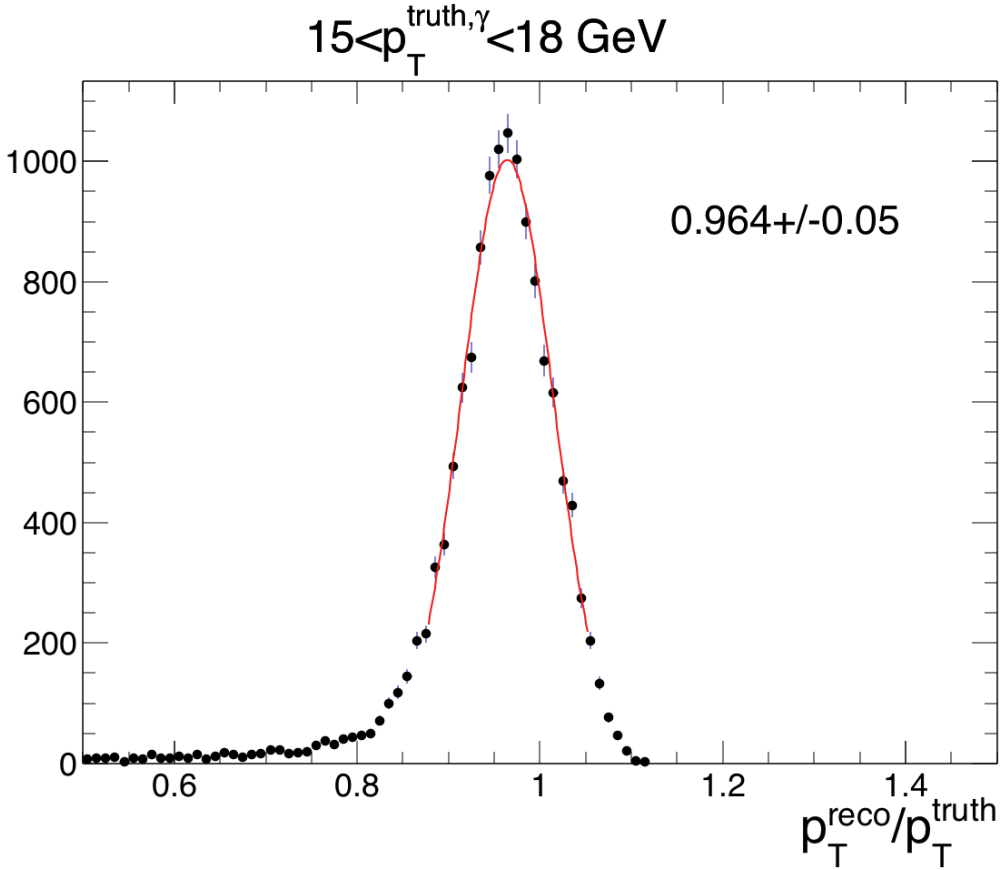

0<p_T^truth,γ<3 GeV
0.962+/-0.092
500
400
300
200
100
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

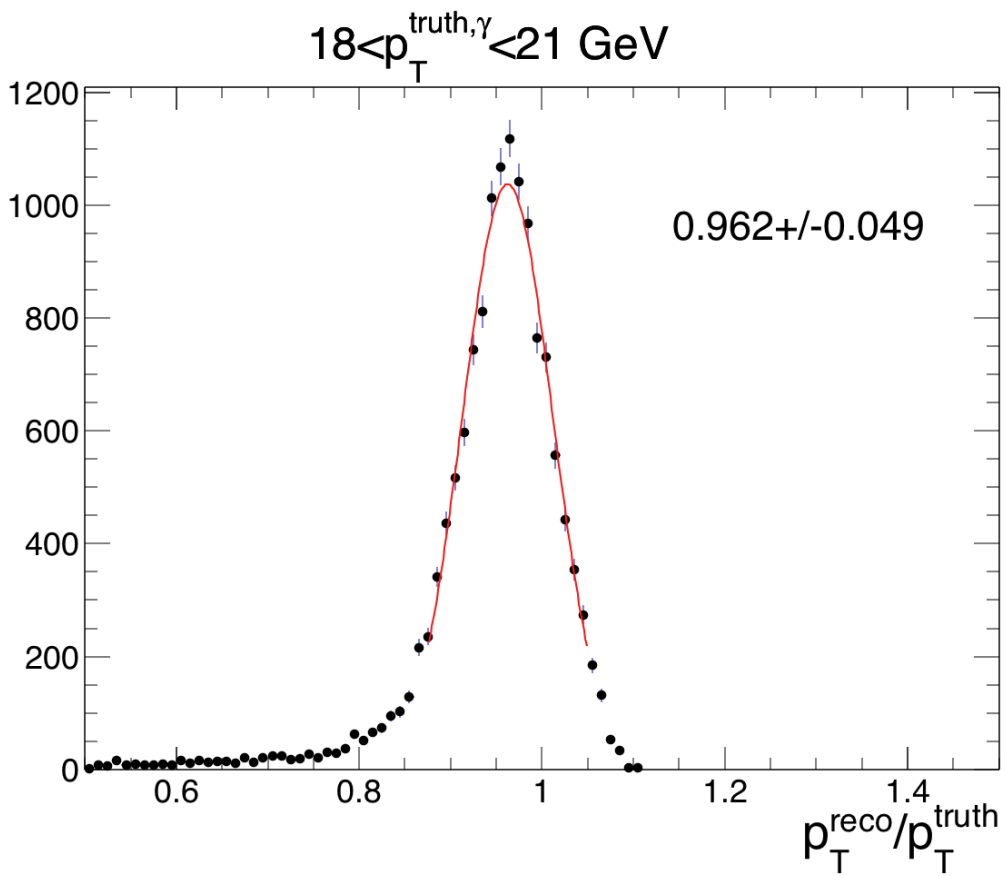

3<p_T^truth,γ<6 GeV
0.971+/-0.063
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

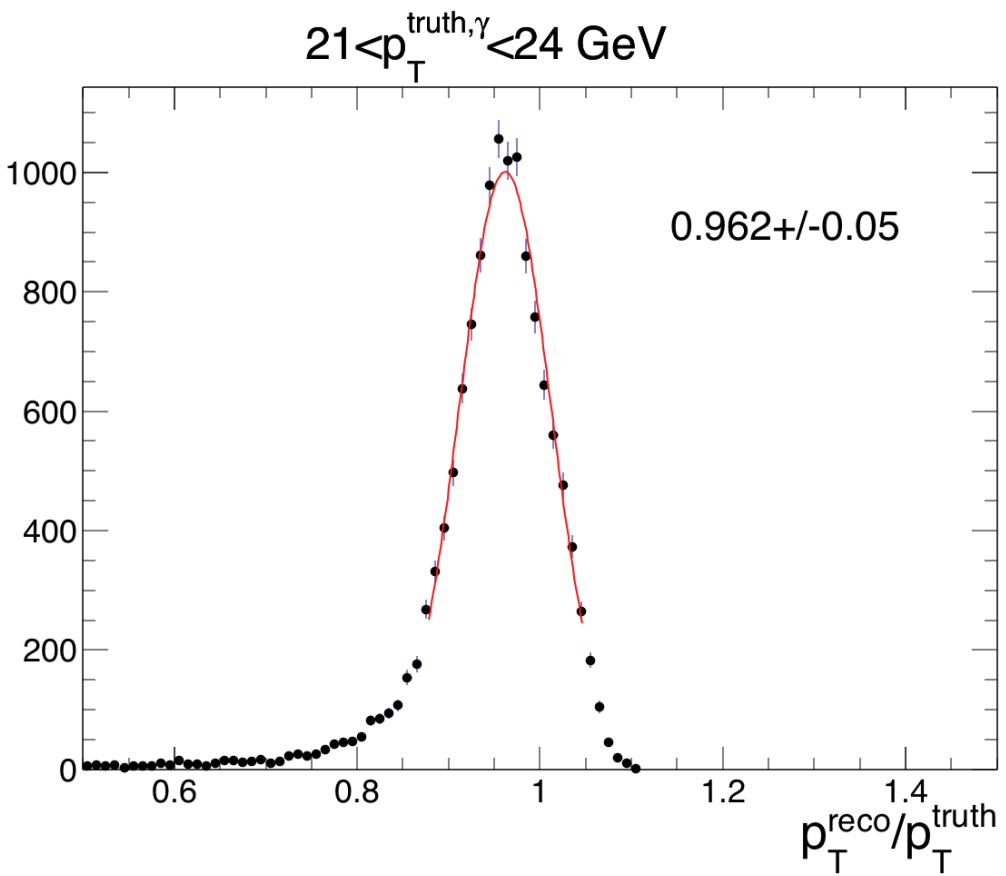

6<p_T^truth,γ<9 GeV
0.969+/-0.056
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

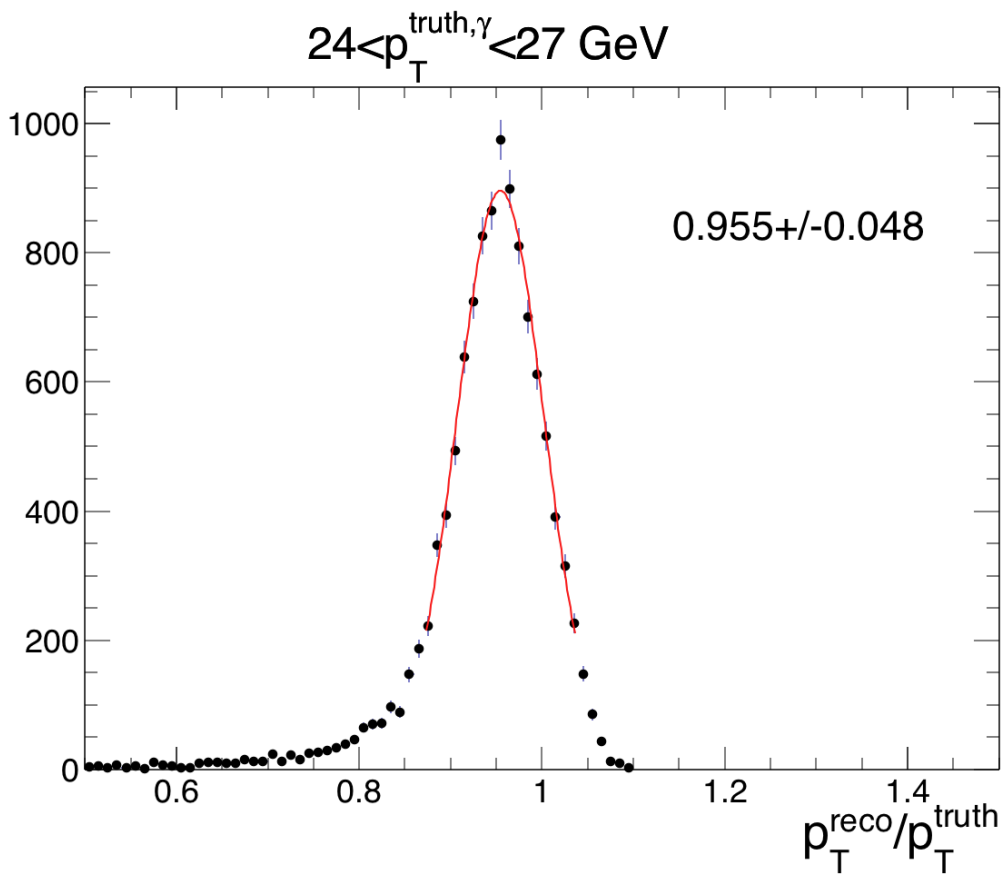

9<p_T^truth,γ<12 GeV
0.967+/-0.054
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

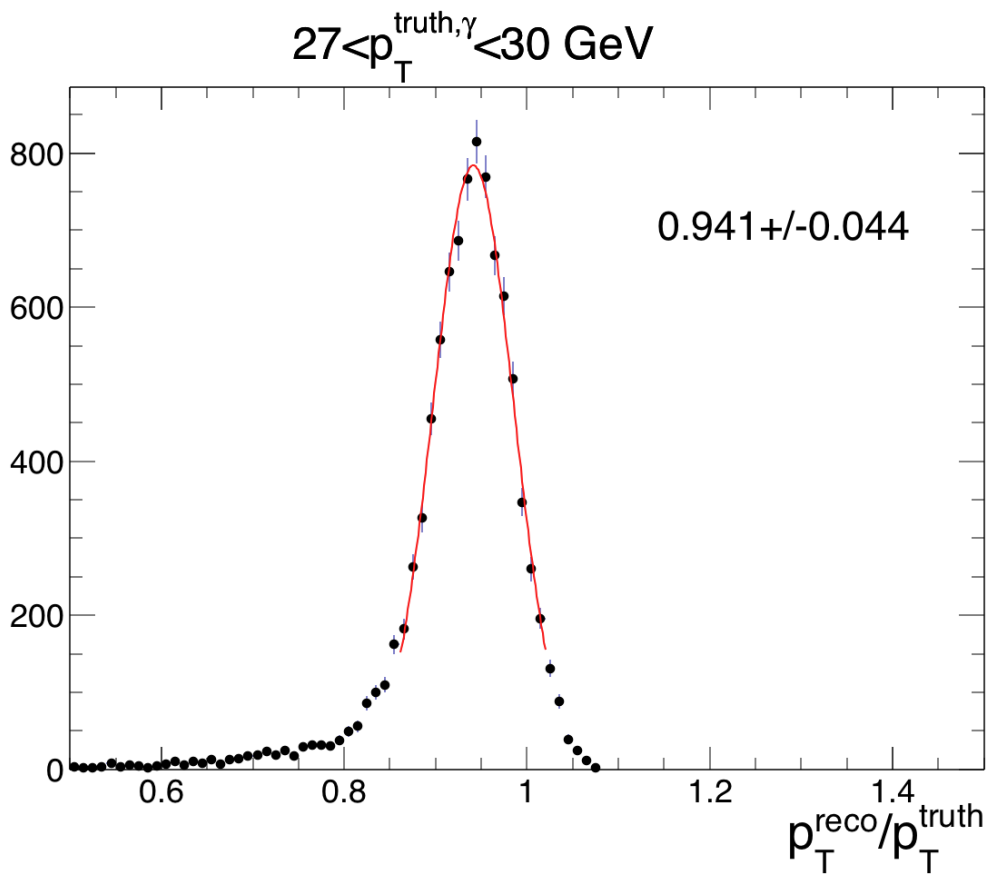

12<p_T^truth,γ<15 GeV
0.966+/-0.051
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

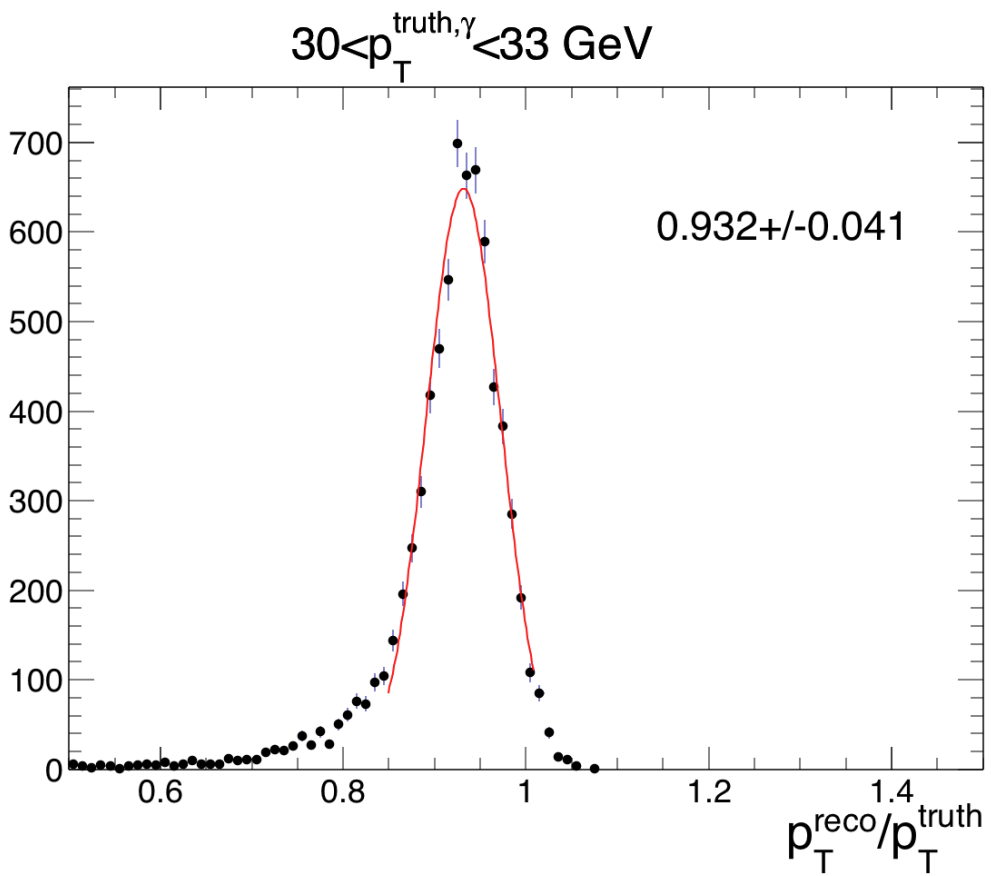

15<p_T^truth,γ<18 GeV
0.964+/-0.05
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth

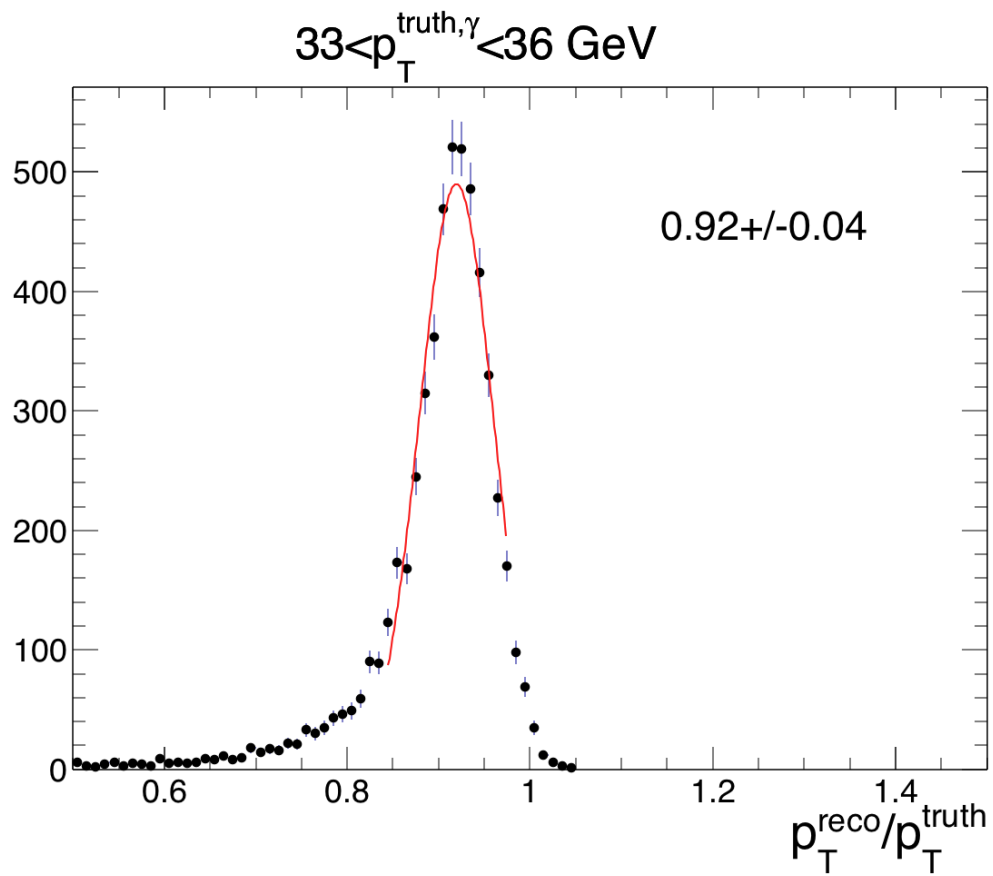

18<p_T^truth,γ<21 GeV
0.962+/-0.049
p_T^reco/p_T^truth

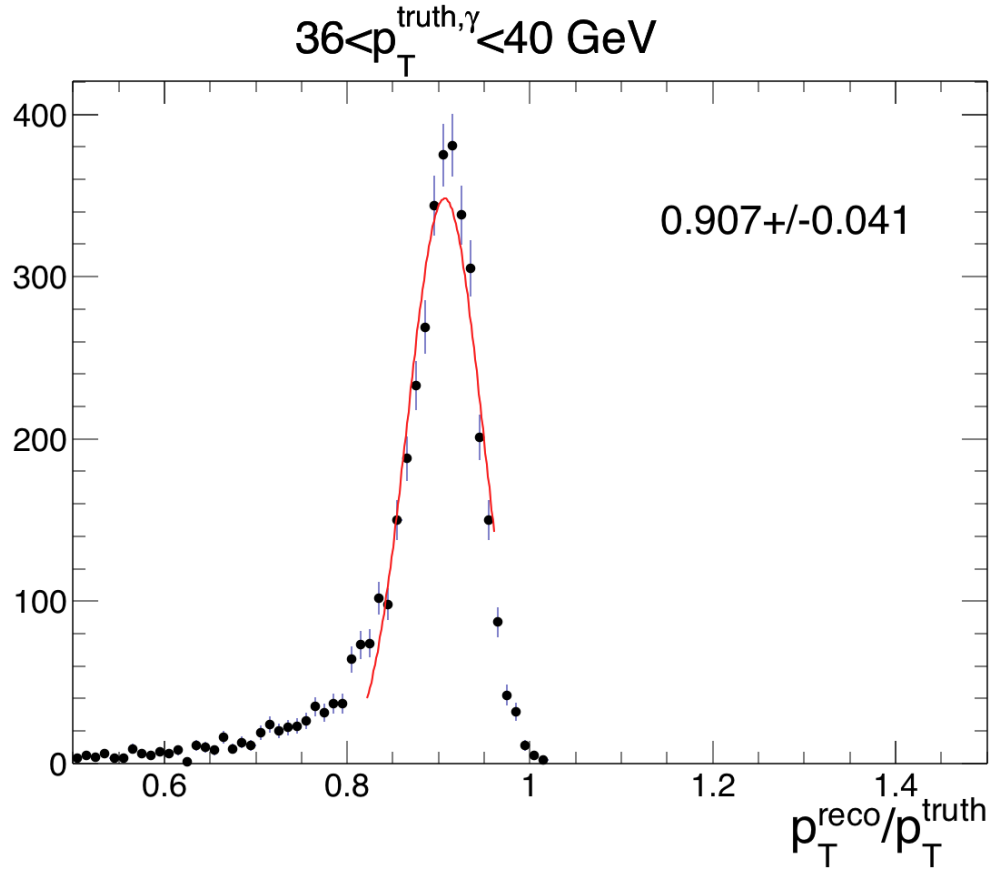

21<p_T^truth,γ<24 GeV
0.962+/-0.05
p_T^reco/p_T^truth


24<p_T^truth,γ<27 GeV
0.955+/-0.048
1000
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth


27<p_T^truth,γ<30 GeV
0.941+/-0.044
800
600
400
200
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth


30<p_T^truth,γ<33 GeV
0.932+/-0.041
700
600
500
400
300
200
100
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth


33<p_T^truth,γ<36 GeV
0.92+/-0.04
500
400
300
200
100
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth


36<p_T^truth,γ<40 GeV
0.907+/-0.041
400
300
200
100
0
0.6
0.8
1
1.2
1.4
p_T^reco/p_T^truth